ARAGÓN GEOTECHNICAL, INC.
Consultants in the Earth & Material Sciences

PRELIMINARY GEOTECHNICAL INVESTIGATION
TENTATIVE TRACT MAP NO. 37154
APN 290-160-011
TEMESCAL VALLEY, RIVERSIDE COUNTY, CALIFORNIA

FOR
THE HIGHLANDS AT SYCAMORE CREEK, LLC
4338 PALAZZO LANE
CORONA, CALIFORNIA 92883

IN COOPERATION WITH
ADKAN ENGINEERS
6879 AIRPORT DRIVE
RIVERSIDE, CALIFORNIA 92504

PROJECT NO. 4252-SF
JANUARY 30, 2017

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January 30, 2017
Project No. 4252-SF

The Highlands at Sycamore Creek, LLC
4338 Palazzo Lane
Corona, California 92883

Attention: Mr. Jorge Orozco

Subject: Preliminary Geotechnical Investigation Report
Tentative Tract Map No. 37154
APN 290-160-011
Temescal Valley, Riverside County, California.

Gentlemen:

In accordance with our proposal dated April 17, 2014 and later addenda, Aragón Geotechnical Inc. (AGI) has completed a Preliminary Geotechnical Investigation for the above-referenced subdivision project. Entitlement is being sought for 13 residential parcels and other remainder lots on a 34.14-acre rural-residential ranch. The small tract has been conceptualized for a relatively flat portion of the property and will not encroach into higher-relief terrain that composes the bulk of the site. We infer that undeveloped areas will be managed as open space. Mass grading is proposed for the home sites and future streets. The attached report details AGI findings, opinions, and recommendations developed as a result of surface observations, subsurface exploration, field and laboratory testing, and engineering and geological analyses.

AGI's geotechnical studies were conducted concurrently with a geological hazards investigation for active fault rupture potential. Previously undocumented fault hazards were identified during the investigation. Avoidance zones were delineated and are shown on an exhibit accompanying this report. Geotechnical report subsections also provide condensed versions of geological unit descriptions and structural interpretations for the tract area. However, in-depth technical discussions of site units, fault offset magnitudes, recurrence rates, fault kinematics, and tectonic setting are included in a companion *Earthquake Fault Hazard Investigation* report under separate cover.

Geotechnical observations and data from 5 deep exploratory soil borings, 5 exploratory fault trenches, and several existing hillside cuts were used to characterize local soil and bedrock units. Two residences, outbuildings and sheds, stock corrals, and an unused lined pond for irrigation water are the main existing site improvements. There is one known on-site water well. Non-engineered fills are scattered around the property. The site is not known to have been used for groves or tilled annual crops, however.

Development is expected to encounter native colluvium and stream-deposited alluvium, plus two bedrock units. Dark-colored colluvium has limited distribution but must be entirely removed from fill or building areas due to compressibility. Younger fan alluvium occupies most flatter and lower-elevation parts of the project. The upper parts of younger alluvium are loose and often disturbed by burrowing fauna. These soils are judged compressible to depths ranging between about 5 to 10 feet. Four lots will partially overlie metamorphic and granitic bedrock in addition to alluvium.

Groundwater was not encountered in any explorations to the maximum depth explored of 61.5 feet. Static groundwater in a defunct off-site water well just 210 feet from the north property line was measured at over 146 feet deep in May, 2016. AGI has postulated that groundwater can, on rare occasions, rise to possibly 15 to 40 feet below ground surfaces for brief periods during storms in wet years.

Geologic constraints to development will require inclusion of structural measures to mitigate the high likelihood of strong earthquake ground motions at the site. Probabilities of buildings being affected by liquefaction and related side effects (settlement, fissuring, ground loss from sand boils, lateral spread), gross instability or landsliding, seiching, induced flooding, and tsunami appear to range from very low to zero. Debris flow hazard is interpreted close to the canyon mouth located south of the development lots. Basins and flood water catchment improvements will be needed. AGI's predicted shallow-groundwater conditions would be ephemeral and should in any event remain within dense older soils that are not susceptible to liquefaction.

Findings indicate the site should be relatively easy to prepare for the planned improvements, from a geotechnical viewpoint. Remedial grading for lots and streets is recommended to remove and replace as engineered fill: (1) All existing fills; (2) All colluvium; and (3) Surficial zones of the younger alluvium, over a depth range we anticipate will be roughly 4 to 15 feet but averaging near 10 feet. Cut-pad and transition lot subexcavations are recommended in residential lots that expose bedrock or would be transected by cut-fill daylight lines. All clean site-derived soil materials are considered suitable for reuse in structural fills.

AGI recommends that all fill slopes not exceed a maximum 2:1 (H:V) inclination. Bedrock cut slopes are currently proposed at suitable 2:1 inclinations, but may optionally be designed up to 1.5:1 along the eastern side of the tract. Existing cut slopes can be left alone, in our opinion. A degraded and abandoned cut located west of the proposed lots is sufficiently far from development to not pose dangers. A superficially similar cut above lots along the eastern tract margin has performed well for decades, and meets qualitative and geometric analyses for rock slope stability. The project design concept incorporates a recommended protective bench for the eastern slope.

It is AGI's conclusion that properly designed shallow strip footings and spread foundations should provide adequate structural support for homes. Building foundations should bear entirely upon engineered compacted fill. In addition to foundation design guidelines, including preliminary recommended design values for both vertical and lateral loads, this report presents recommendations for site earthwork, prescriptive code values for use in seismic groundshaking mitigation, concrete mix designs, and construction observation. Compatibility of foundation, grading, and retaining wall plans with AGI preliminary recommendations must be verified by plan reviews when civil drawings become available.

We are grateful for the opportunity to help the owner mitigate development risks and achieve a quality, long-lasting project. Please ask for either of the undersigned at our Riverside office if you should have any questions.

Very truly yours,
Aragón Geotechnical, Inc.

Mark G. Doerschlag, CEG 1752
Engineering Geologist

C. Fernando Aragón, P.E., M.S.
Geotechnical Engineer, G.E. 2994

MGD/CFA:mma

Distribution: (4) Addressee

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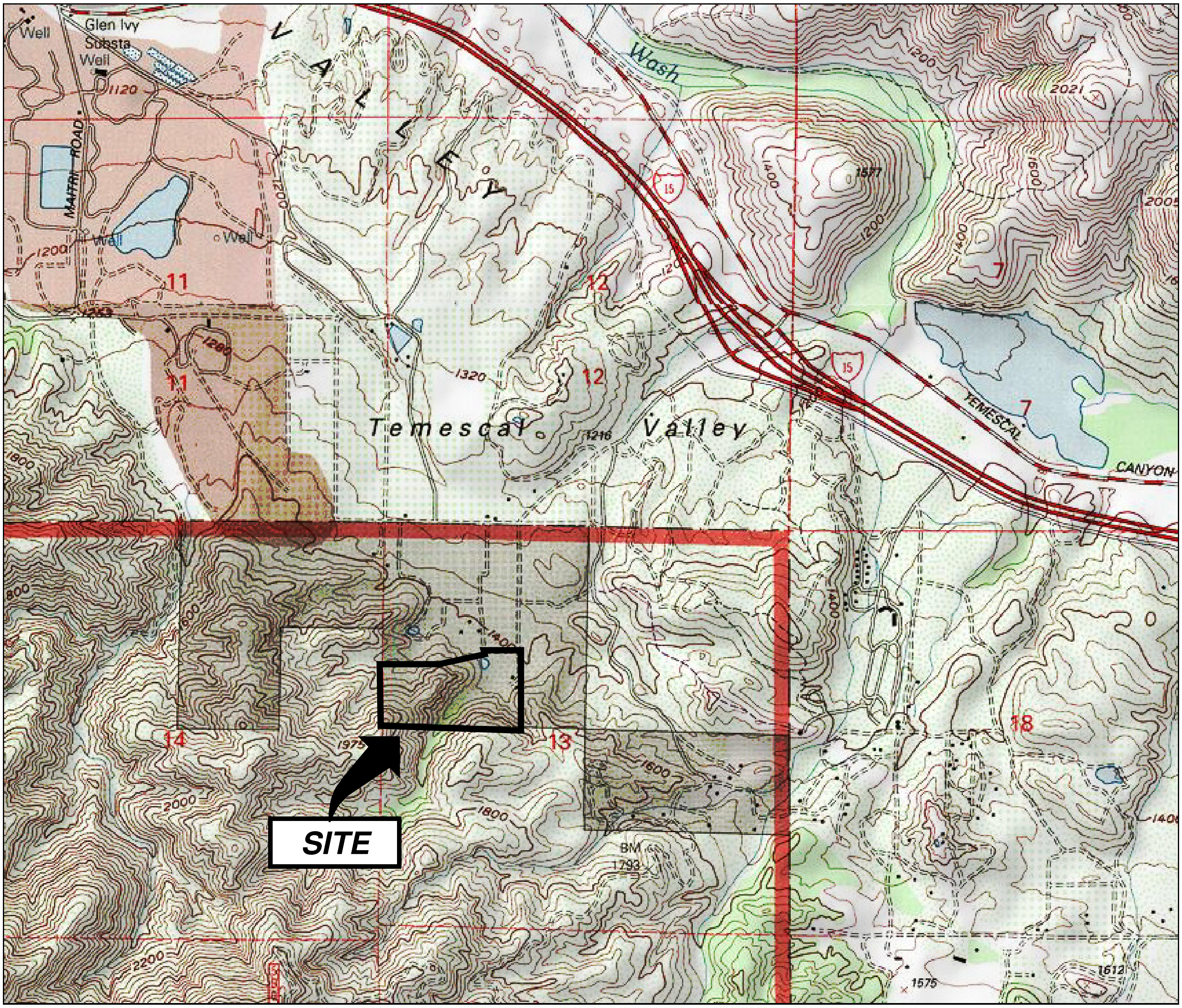
TENTATIVE TRACT MAP NO. 37154
TEMESCAL VALLEY, RIVERSIDE COUNTY, CALIFORNIA

1.0 INTRODUCTION

This report presents the results of preliminary soils engineering and geological evaluations conducted by Aragón Geotechnical, Inc. (AGI) for a proposed 13-lot residential subdivision in the unincorporated community of Temescal Valley, Riverside County. Tentative Tract Map (TTM) entitlement actions are being sought for a parcel identified in the Riverside County Land Information System as APN 290-160-011. The listed parcel area of 34.14 acres will be reduced slightly when lot line adjustments are completed to transfer a road alignment into a tract in the adjacent Sycamore Creek Specific Plan. Geographic coordinates are 33.7370°N x 117.4632°W near the geometric center of the proposed array of homesites. Situs per the Public Land Survey System is the NW¼ of Section 13, Township 5 South, Range 6 West (San Bernardino Baseline and Meridian). The accompanying Site Location Map (Figure No. 1) depicts the approximate subdivision boundaries with respect to older community roads and surrounding natural terrain on a 1:24,000-scale topographic base map. The shaded-relief index map is out-of-date with respect to regional growth, however, and lacks many newer cultural features added to the area in the last decade.

The primary objectives of our studies were to (1) Determine the nature and engineering properties of the subsurface materials underlying the project site in order to verify suitability for residential development; and (2) Provide preliminary foundation design, grading, and construction recommendations. Accordingly, our scope included property reconnaissance, aerial photo interpretation, geologic literature research, geological mapping, subsurface exploration, recovery of representative soil samples, laboratory testing, and geotechnical analyses. Environmental services such as Phase I or Phase II environmental site assessments, or contaminant testing of air, soil, or groundwater found in the project site, were beyond the scope of this geotechnical investigation.

AGI's geotechnical studies were completed concurrently with a required surface fault rupture hazard investigation within the subject property. Authorized services included additional fault and geotechnical investigations for two neighboring parcels (under affiliated ownership). The opportunity to expand the geographic limits of our field studies and increase the number of explorations greatly improved our geologic site model. The



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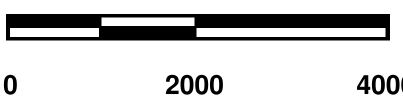
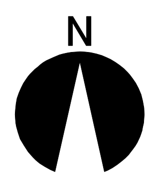




Reference: U. S. Geological Survey 7½-Minute Series Topographic Maps,
Lake Mathews and Alberhill Quadrangles (1997).
Site outline is approximate.

AGI

SITE LOCATION MAP

TENTATIVE TRACT MAP NO. 37154, TEMESCAL VALLEY, CALIF.

PROJECT NO. 4252-SF	DATE: 1/30/17	**FIGURE 1**

findings and recommendations for TTM No. 37154 are to a great degree interdependent on data from these sister sites:

- APN 290-160-013 and 290-160-014, consisting of a little less than 8 acres of rural-residential land next to the northern side of TTM No. 37154. Riverside County entitlements are being processed for a potential 19-lot subdivision, TTM No. 37027.
- APN 290-150-004, encompassing around 54 acres of undeveloped hilly terrain slated for limited medium-density tract development [TTM No. 37155] and conserved open space.

Subsurface work has delineated the width and trend of an active fault zone in TTM No. 37154 deemed to pose a continuing threat of surface offset. The fault zone is part of the active Glen Ivy South Fault as originally identified by Weber (1977). Mitigation by avoidance of the rupture zone is the sole allowed structural remedy under current State law. AGI's companion *Earthquake Fault Hazard Investigation* report for the tract details the completed study scope and our derivations of defined "Restricted Use Zones" and "Buildable Areas" (AGI, 2017). The fault hazard report also incorporates detailed technical subsections concerning the regional and local geologic setting, soil and bedrock units, regional seismicity, and project risks from strong earthquake ground motions. We have placed condensed versions of the latter topics in this geotechnical report. Extended geological and geotechnical assessments of permanent ground deformation unrelated to rupture hazard such as liquefaction, settlement, and land instability, as well as site risks from other induced seismic hazards, groundwater, expansive or collapsible soils, flooding, and debris flow are placed in this volume. All named hazards were analyzed using an array of Internet-based tools, published resources, investigation findings for neighboring projects, site-specific data, quantitative analyses, and local case-history experience.

2.0 PROPOSED CONSTRUCTION

AGI was furnished with the latest-available project civil engineer's conceptual development plans, subsequently used as a base map for AGI's Geotechnical Map, Plate No. 1 (back pocket). The subdivision will be sited in territory re-zoned for very-low-density residential from previous R-R zoning per an enacted general plan amendment. The western and northern sides of APN 290-160-011 partially abut County-approved Tract No. 36317 [BGR 140071; GEO 02232], a 192-lot subdivision that is part of the Sycamore Creek Specific

Plan. Construction of Tract No. 36317 had not yet started during AGI's studies. Access for the 13 roughly quarter-acre homesites would be from an extension of an approved street passing through the neighboring subdivision. Two remainder lots will encompass a pair of proposed water-quality infiltration trenches, and close to 30 acres of high-relief canyon and ridgeline open-space area in the central and western thirds of the property. We anticipate that the open-space terrain will remain undisturbed other than for possible limited trail improvements.

Structural design plans or architectural elevations for the future residences were not available for review. However, we have assumed construction will rely on conventional chipboard-sheathed, wood-stud balloon framing with concrete slabs-on-grade and shallow continuous strip footings. One- and two-story residential construction should impose only light to moderate foundation loads. Appurtenant tract features would include buried wet and dry utility infrastructure including municipal sewer hookups, and residential street improvements.

Future mass grading will involve cuts and fills topping out at around 19 feet and 12 feet, respectively. Quantities were not calculated on the available civil plans, but AGI believes the project will be designed to achieve balanced cut and fill volumes. Substantial increases in total earthwork volumes are expected from "raw" quantities after accounting for remedial site grading and cut-lot overexcavations detailed later in this report. Manufactured permanent cut slopes will be created in alluvium and bedrock materials. Modest engineered fill slopes up to around 17 feet high will accommodate pad elevation differences across the array of lots. All slopes are depicted at inclinations of 2:1 (horizontal:vertical), with one exception of a 1.5:1 transition slope above an interpreted fire protection road. The preliminary tract plans show 3 retaining walls that should not exceed 6 feet or so in height. The walls will retain sloped ground, though. There are no existing public street rights-of-way that will be affected by site mass grading.

3.0 FIELD INVESTIGATION AND LABORATORY TESTING

Subsurface site exploration comprising 5 exploratory soil borings was completed by AGI on April 12, 2016. Drilling was completed after backfilling of 5 fault investigation trenches. Soil boring and fault trench locations are shown on the Geotechnical Map. The fault trenches comprised wide, benched excavations ranging between approximately 10 and 20 feet deep at the centerline. Trenches of course afforded opportunity for physical entry and extraordinarily detailed visual assessments of soil texture, internal structure (layering), and other characteristics. Three of the five trenches also encountered bedrock. Equipment performance in bedrock was useful for assessing rippability. Many judgments of future geotechnical performance outlined in later report sections were based in part on the trench observations. However, data from soil and rock units located deeper than 20 feet, plus *in situ* tests and recovered soil samples from borings, were required for comprehensive site characterization.

Site access impediments were posed by existing structures, fences, livestock enclosures, a man-made reservoir basin, and native oak trees. Nonetheless, AGI-selected drilling localities were considered adequate to (1) Ascertain the classifications, relative densities, possible origins, and depths of detrital soils; (2) Find the top of buried bedrock units, where reasonably achievable; (3) Check for the presence of shallow groundwater; and (4) Acquire representative samples of local earth materials for laboratory testing.

The 5 soil borings were drilled with a truck-mounted hollow-stem auger rig capable of driving and retrieving soil sample barrels. Two of the soil borings encountered bedrock; one bedrock boring was terminated by rig refusal. Achieved depths ranged from 20.3 feet to 61.5 feet. Relatively undisturbed samples of soil were recovered by driving a 3.0-inch-diameter "California modified" split-barrel sampler. In the deeper portions of each drill hole, Standard Penetration Tests were performed with a 2.0-inch-diameter split spoon. All sampler driving was done using rods and a mechanically actuated automatic 140-pound hammer free-falling 30 inches. Additional representative bulk samples of soil cuttings from auger borings were bagged. All geotechnical samples were brought to AGI's Riverside laboratory for assigned soils testing.

Drill cuttings and each discrete soil sample were visually/manually examined and classified according to the Unified Soil Classification System, and observations made concerning relative density, constituent grain size, visible macro-porosity, cementation, plasticity, and past or present groundwater conditions. Bedrock was described in conformance with ISRM terminology for weathering, hardness, strength, and rock mass discontinuities. Descriptions and test performance data were recorded by a senior Engineering Geologist, and the results are presented on the Field Boring Logs in Appendix A.

All “undisturbed” samples were tested for unit dry density and water content. Selected barrel samples of alluvium were tested for consolidation/collapse behavior. The recovered bulk soil samples were evaluated for index and engineering properties such as remolded shear strength, compaction properties, expansion potential, and corrosivity characteristics. Discussions of the laboratory test standards used and the test results are presented in Appendix B.

4.0 SITE GEOTECHNICAL CONDITIONS

4.1 Previous Site Uses

AGI’s scope included limited historical research to ascertain changes to surficial conditions through time, and address known or possible geotechnical impacts to project design or construction. Stereoscopic aerial photographs archived at the Riverside County Flood Control and Water Conservation District headquarters in Riverside, California, were interpreted for evidence of past structures, land use, and for geological assessments of active faulting potential and geomorphic history. The Google Earth Pro application provided additional monoscopic historical imagery. Lastly, digitized older topographic map quadrangle sheets dating to 1953 were downloaded for analysis (U.S. Geological Survey, 2017a). Reviewed photographs and maps are listed under “References” at the end of this report.

We have deduced that initial improvements on the site, including two mobile homes, were installed between 1954 and 1962. All structures were limited to the flatter northeastern corner of the property, just beyond the mouth of a major canyon drainage. Images from 1962 showed the developed area as cleared of brush and grasses, while groves of mature Engelmann oaks were retained. An incised natural stream channel passed through the middle of the small ranch complex. A concrete-lined reservoir was already built near today’s proposed residential Lots 5-7. To the west, a new or nearly-new and crudely built dozer road switchbacked up a mountain ridge to a series of small flat cut pads. No structures are inferred to have been placed on these pads.

Between 1962 and 1984, episodic grading filled in the natural stream channel and relocated the ephemeral stream course to the present-day alignment farther northwest. An elevated cut-and-fill pad we have informally termed the “East cut” was created on a hillside near the eastern property line. In 1984 a mobile home was present on the pad, but the structure was removed within a few years. A similar pad ("West cut") may have been intended on the west side of the canyon mouth, but grading was apparently halted before reaching completion. Most low-relief areas were divided into equestrian enclosures. The concrete-lined reservoir was almost always filled with water. The subject site was never used for agriculture, however, and the stored water was presumably used for citrus acreage in what would become the Sycamore Creek Specific Plan. We understand that a canyon spring located some distance south of the property supplied the water via a pipeline. Citrus groves in future Tract No. 36317 north of the subject property were well-maintained and vigorous through the 1980's and 1990's.

Almost no discernable on-site changes occurred between 1984 and AGI's site investigations. Year-2005 photos showed the installation of a new Lee Lake Water District [Temescal Valley W.D.] steel reservoir adjacent to the northwestern property corner. Cut-and-fill grading was employed to lower the top of a small bedrock knob to create a tank pad and paved access road. Also around 2005, mass grading started to develop portions of the Sycamore Creek Specific Plan closer to the Interstate 15 freeway. Citrus groves next to the property were removed by 2010. The last few years have seen housing subdivisions, collector roads, and a Riverside County regional park steadily encroach toward the project site. Next to the northern property line, a concrete-lined trapezoidal diversion channel, culvert, and grouted rip-rap dissipator for floodwater and debris flows was completed in 2015. The facility is owned and maintained by the Riverside County Flood Control and Water Conservation District.

4.2 Surface Conditions

The property limits are bordered by mountainous terrain to the south and west that is part of the Cleveland National Forest. To the north is the aforementioned Temescal Valley W.D. reservoir property, portions of future Tract No. 36317, and acreage that will be retained as open space south of future subdivided residential lots within Tentative Tract Map No. 37027. Vacant, chaparral-covered hillsides abut the east side of the project. The partially fenced site is easily approached on private dirt roads extending south from developed portions of Sycamore Creek.

Existing site improvements include the two residences and their related overhead electric utility services. Domestic wastewater is presumed to be treated on-site via septic tanks and absorption fields. The residences have reportedly been continuously occupied by tenants for years. Storage buildings, canopies, sheds, equestrian shelters, and similar outbuildings dot the site. There is a functional water well serving the property. Exotic trees are clustered near the homes. Native oaks and sycamores form dense groves on north-facing slopes and in the canyon bottom to the south.

Pipe corrals divide the bulk of the proposed house pad and street areas. At the time of AGI's field investigation, a few horses were present on the property. Observations indicated there was very little animal manure present and that soil surfaces remained preponderantly mineral grains. The site appeared clean and maintained. Small piles of inert debris, tractor implements, and abandoned water pipes were locally present.

The tract boundaries encompass varied terrain ranging from smooth, low-gradient alluvial fan areas to steep and very brushy slopes that continue rising off-site to the south into the greater Santa Ana Mountains. Even the steepest slopes are usually mantled with soil, though. A notable attribute of local terrain is the near-absence of large surface rocks or conspicuous natural rock outcroppings. On-site bedrock exposures are for the most part limited to man-made cut slopes and dozer roads. Alluvial areas generally lack surface stones larger than cobbles, although excavations are expected to find some boulders. Residential development will be concentrated in the flat alluvial areas where natural gradients are mostly under 6 percent. As-built relief within the residential areas upon project completion is expected to be approximately 55 feet. Total relief in the property is roughly 495 feet, however. The approximately 30 acres of future open-space mountain slopes and canyon bottom will presumably be managed by a homeowners association or conservation district.

The tract site is a receptor of collected runoff from the canyon watershed to the south. Calculated runoff volumes at the 1% annual probability value are reportedly over 415 cubic feet per second. Steep slopes underlain by bedrock including less-fractured granitic types in the headwater regions have resulted in coarse sediment deposits. A crude unlined ditch diverts smaller canyon discharges away from the residences and equestrian corrals. It is doubtful the channel could contain a large flood event or pulses of rocky debris we would predict in a post-fire condition. The canyon and channel are not classified as intermittent or permanent "blueline" stream courses. Incident rainfall moves as sheetflow runoff perpendicular to local topographic contours. Offsite, the discharges are intercepted by the newly built concrete trapezoidal channel parallel to the northern property line and ultimately directed into neighboring APN 290-150-004.

At the time of AGI's geotechnical investigation, most surface soils had already returned to seasonal dry and dusty conditions after a poor rainfall year. Vegetation in flatter terrain was dominated by sparse dried annuals. Oak trees and non-native landscape vegetation were situated around the residences and the reservoir basin. Dense chaparral was the typical cover in steeper-relief areas.

4.3 Subsurface Conditions

Fill. Man-made fill was absent from the soil borings, but was locally seen in some of the fault trench exposures. Sidehill fills related to the "West" and "East" bulldozer cuts were delineated near the on-site irrigation reservoir and within future backyard areas of proposed Lots 1-4. The reservoir basin incorporated fill berms around a shallow excavation to make the basin floor. Historical aerial images indicated a thin wedge of fill had been placed toward the northeastern property corner to help level the ground surface in livestock corrals. Interpretations hinted that the deepest (non-trench related) on-site fills were unlikely to exceed 8 feet or so. Some small or very thin fills have been omitted from the Geotechnical Map for clarity. Fill soils appeared to consist of site-derived silty sand, gravelly sand, and crushed and fragmented weathered bedrock (silty gravel). We did not observe debris or large rocks in fills. All preexisting fills were classified as undocumented fills.

Native Soils. The flatter and lower-gradient portions of the site featured sequences of younger alluvium, which graded laterally into colluvium deposits near slope toes. Typical younger alluvium was composed of stratified, light brown silty and gravelly sand (Unified Soil Classification System symbol SM) with beds of sandy gravel (GW-GM). Younger alluvium in small tributary drainages was much darker given the clast origins from dark-colored metamorphic bedrock, and graded into silty gravel (GM). Shallow younger alluvium was partly "churned" (bioturbated) by burrowing fauna. The upper soils were judged porous and highly compressible. Cobble-size and larger rocks were common. Fault trenches encountered silty, matrix-supported boulder beds below depths of 11 to 13 feet, indicative of buried debris flow deposits. Boulders were up to at least 36 inches across. The rocks were usually hard and durable. Stratified fluvial deposits were usually non-cohesive and prone to raveling in open excavations. From a soil science viewpoint, the National Resources Conservation Service would probably classify all site younger alluvium as Soboba gravelly loamy sand or Soboba cobbly loamy sand (the project site is just outside of formally mapped terrain). Both soil series are assigned to hydrologic soil group A (NRCS, 2016).

Dark brown silty sand with gravel and traces of clay, silty sandy gravel, and sandy silt comprised a mappable colluvium unit mostly located off-site but edging into the eastern tract limits. The materials were visibly porous and had dense root networks. Colluvium for the most part was interpreted to overlie bedrock. Trenches suggested the unit interfingered with normal fluvial-modified sediments.

All site borings encountered a distinctive very old alluvial unit. The unit is concealed in TTM No. 37154 but is exposed at the ground surface just offsite to the north and northeast. Contacts between younger fan alluvium and the older unit are erosional unconformities. Paleosols were not detected in subsurface explorations. Where unweathered, the older unit was commonly dense to very dense, essentially uncemented, light yellowish brown to pale yellow sand with silt (SP-SM) or gravelly sand (SW-SM). The majority of detrital particles were derived from granitic bedrock. Based on trench exposures in neighboring properties, local concentrations of highly weathered and angular granitic boulders exceeding 24 inches in diameter might be present. The unit was usually thin to medium bedded and plane-laminated.

Bedrock. AGI identifies 3 different bedrock map units inside the tentative tract limits, one of which is almost entirely concealed below detrital sediments. Hilly terrain southwest of active fault zones that will be part of a future open-space area is composed of weathered and fractured metamorphic rock we assign to the Bedford Canyon Formation. Near proposed Lots 1-4, cut slopes expose a different, sometimes notably hard and siliceous metamorphic rock we believe is much older and unrelated to Bedford Canyon rocks. Lastly, a fine to medium-grained and generally highly weathered granitic rock unit has a tiny surface exposure near the eastern tract limits but can be extrapolated as a concealed subsurface unit to the north and west. The older metamorphic rock unit and the granitic unit are expected to be encountered during site development. Sections 5.2 (Local Geologic Conditions), 6.2 (Excavatability), and the boring logs in Appendix A further describe and interpret soil and bedrock conditions in TTM No. 37154.

4.4 Groundwater

Exploratory soil borings did not encounter groundwater to the maximum termination depth of 61.5 feet. AGI found no evidence for present-day or historical occurrence of rising water such as springs, seeps, or clustered phreatophytic vegetation. This was true even for mapped fault zones.

About 210 feet north of TTM No. 37154 and future Lot 5, a defunct water well and windmill are present on neighboring APN 290-160-013. AGI was able to slip an electric water level probe into the well casing. Depth to water was measured at 146.7 feet from the top of casing in early May, 2016. Details of the well's construction were unknown, but we interpreted that the measured phreatic surface was far below the alluvium-bedrock contact in the area. Riverside County bedrock areas often harbor small amounts of permanent groundwater in deep fractures or joints. The elevation could have been at a historical minimum, given multiple preceding drought years. No measurements were obtainable from the (sealed and operating) on-site well.

We think it is likely that average or above-average rainfall seasons result in the development of a short-lived unconfined saturated zone atop bedrock, when mountain watersheds produce copious surface runoff. Within the proposed lot and street areas, we speculate a *maximum* groundwater elevation of roughly 15 feet below ground surfaces closest to the canyon mouth, rapidly descending to somewhere near 40 feet near the northern tract boundary. Evidence for at least transient soil saturation would include iron oxide staining or limonitic spots that we in fact observed in samples from one deep soil boring. The steep bedrock gradients we interpret for the site mean that saturated zones would quickly drain once continuous inputs from surface infiltration stopped.

Based on observations and proposed/recommended earthwork, our preliminary opinion is that groundwater will not impose design or construction limitations on the project. Rising water potential is predicted to be low. Final grading plans and in-grading geological observations would determine whether and where any subdrain installations would be prudent. Fluctuations in local groundwater elevations should be expected to continue indefinitely, consistent with variations in precipitation, temperature, consumptive uses, local stormwater recharge, and other factors.

5.0 ENGINEERING GEOLOGIC ANALYSES

5.1 Regional Geologic Setting

The majority of western Riverside County including the Temescal Valley area lies within the Peninsular Ranges Physiographic Province, one of 11 continental provinces recognized in California. The physiographic provinces are topographic-geologic groupings of convenience based primarily on landforms, characteristic lithologies, and late Cenozoic structural and geomorphic history. The Peninsular Ranges encompass southwestern California west of the Imperial-Coachella Valley trough and south of the escarpments of the San Gabriel and San Bernardino Mountains. The province is characterized by youthful, steeply sloped, northwest-trending elongated ranges and intervening valleys.

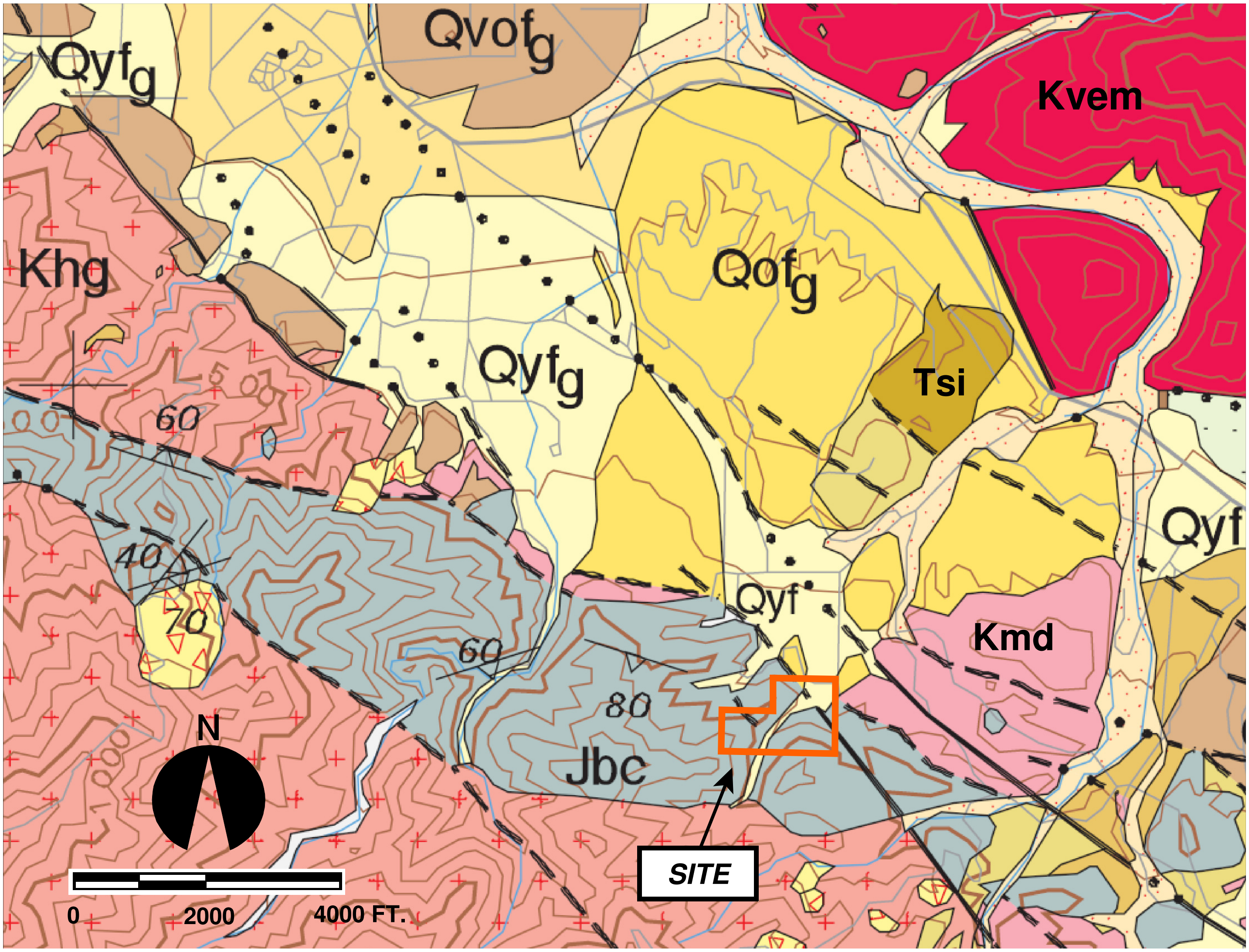
Structurally, the Peninsular Ranges province in California is composed of several relatively coherent, elongated crustal blocks bounded by active faults of the San Andreas transform system. Although some folding, minor faulting, and random seismic activity can be found within the blocks, intense structural deformation and large earthquakes are mostly limited to the block margins. Exceptions are most notable approaching the Los Angeles Basin, where compressive stress gives rise to increasing degrees of vertical offset along the transform faults and a change in deformation style that includes young folds and active thrust ramps. Temescal Valley represents the geomorphic expression of the structural “seam” between the Santa Ana Mountains and Perris crustal blocks. Multiple active, inactive, and often overlapping fault segments that are members of the Elsinore fault zone have splintered the margins of these two major blocks. Right-lateral transform movement and some vertical offset has given rise to several large, partially interconnected basins beginning near Temecula and extending at least as far as Corona.

The Peninsular Ranges structural blocks are dominated by the presence of intrusive granitic rock types similar to those in the Sierra Nevada, although the province additionally contains a diverse array of metamorphic, sedimentary, and extrusive volcanic rocks. The metamorphic rocks represent the highly altered host rocks for the episodic emplacement of Mesozoic-age granitic masses of varying composition. Coastal parts of the province include thick sequences of younger marine and non-marine clastic sedimentary rocks of Mesozoic and Tertiary age, ranging from claystones to conglomerate. Some of the latter sedimentary units are also preserved in tectonically displaced fragments between Corona and Lake Elsinore. Slightly farther inland, pre-Quaternary sedimentary rocks become conspicuously rare. The Perris tectonic block, for example, is dominated by crystalline basement materials.

5.2 Local Geologic Conditions

The Geotechnical Map outlines the limits of six surficial natural-soil and bedrock units plus several undocumented fill areas (Plate No. 1). AGI has mostly retained the rock and alluvial soil unit nomenclature of Morton and Miller (2006). However, we have independently arrived at several novel correlations of site units with other, differently named formation units located mostly in the Lake Elsinore region. Our scientific hypotheses are discussed more fully in the companion *Earthquake Fault Hazard* report. An excerpt of Morton and Miller's (2006) regional-scale map is presented on Figure No. 2. From oldest to youngest, the mapped on-site natural geological units are briefly considered as follows:

Phyllite & Quartzite (Ŧmu, Triassic): Purplish to nearly black and sometimes fissile metapelite and hard quartzite. AGI's tentative unit correlation is based on structural position, hints of tight internal folding that is cross-cut by foliation in contrast to more-widespread and younger metamorphic rocks, and visual similarity to identified Triassic rocks located farther east per Morton and Miller (2006). The Figure No. 2 regional map errs in lumping all on-site metamorphic rocks into the Bedford Canyon Formation. Good exposures occur in the "East cut" east of Lots 1-4. Here the rock ranges between a very closely fractured and very fine-grained slaty material with a mica sheen on foliation partings to more-massive and hard quartzite. Narrow to tight, east-dipping to near-vertical shears without crushed-rock gouge occur in the unit. The



Selected geologic units:

Qyf, Qyf_g *Younger alluvial fan deposits [Holocene and late Pleistocene]*

Qof_g *Older, gravelly alluvial fan deposits [late to middle Pleistocene]*

Tsi *Silverado Formation: Weakly lithified conglomerate, sandstone, siltstone, and clay beds [Paleocene]*

Kvem *Estelle Mountain Volcanics: Porphyritic rhyolite flows & breccia rocks [Cretaceous]*

Kmd *Unnamed monzodiorite (AGI label), possibly translocated from Paloma Valley Ring Complex [Cretaceous]*

Khg *Heterogeneous granitic rocks, primarily medium to coarse-grained tonalite near site [Cretaceous]*

Jbc *Bedford Canyon Formation: Low-grade weakly foliated argillite, impure quartzite [Jurassic]*

Reference: Modified after Morton and Miller (2006). Site outline and map scale are approximate.

AGI	VICINITY GEOLOGIC MAP		
	TENTATIVE TRACT MAP NO. 37154, TEMESCAL VALLEY, CALIF.		
	PROJECT NO. 4252-SF	DATE: 1/30/17	**FIGURE 2**

cut slope exhibits deep scoring from bulldozer tools and is inferred to have been entirely machine-ripped to maximum as-built depths of around 15 to 18 vertical feet below original grade.

Bedford Canyon Formation (Jbc, Jurassic): Primarily fine-grained, faintly layered or massive wacke and impure quartzite. These low-grade meta-sedimentary rocks were the host rocks for younger intrusive granitic bodies in the Santa Ana Mountains. Thin dikes and irregular pods of coarse-grained tonalite can be found in the western third of the property such as along the ridgecrest south of the Temescal Valley W.D. tank. The unit weathers into smooth soil-mantled slopes. Natural outcroppings are usually inconspicuous, but bolder man-made exposures can be found along roadcuts. Compositional layering (possibly relict primary sedimentary bedding) and sporadic layer-parallel foliation within the unit generally strike close to east-west, with steep southerly dips. Foliation is usually very poorly expressed and not an important contributor to plane discontinuities (partings) in rock masses. Joint sets are generally steep. Discontinuities range from planar and quite smooth closed fractures to wavy and rough joints. Near the surface the metamorphic unit is mostly moderately to highly weathered and moderately hard. Shear zones are very common, though, and broad northwest-trending belts of intensely fractured and relatively soft rock can be traced in the mountain ridges southwest of the proposed lots.

Monzodiorite (Kmd, Cretaceous): Consists of fine- to locally medium-grained, speckled, quartz-poor, and weakly foliated leucocratic granitic rock. The unit was extensively encountered in AGI's fault trench FT-3. Monzodiorite is mapped for some distance east of the project where the typical geomorphic expression comprises eroded, rolling slopes that are free of residual corestones. Natural outcroppings are rare. The sole on-site surface exposure is in the man-made cut in future Lots 2-3. Granitic basement rock is interpreted to continue as a concealed unit towards TTM No. 37027, where it was found in one drill hole, and thence as a (fault-bounded?) sliver in the hills south of a large surface mining operation (AGI, 2016b; Figure No. 2). The monzodiorite is often pervasively sheared, closely to intensely fractured, soft, crumbly, and highly to extremely weathered. Monzodiorite touches older metamorphic host rocks along mildly sheared intrusive contacts. The Geotechnical Map depicts a concealed intrusive contact passing through the property and into neighboring tracts.

Older fan alluvium (Qof, Pleistocene). Older alluvium lies beneath Holocene-age alluvium on the site. Older alluvium is distinctively pale yellow to light yellowish brown, and often well-stratified with plane and shallow-angle cross-lamination. Detrital grains tend to be "gritty" angular or immature particles. In adjacent TTM No. 37027, cobbles and angular to subangular and highly weathered boulders up to 30 inches occur singly or in thick layers or channels(?) that were found in fault trenches. Similar weathered boulders could be present on the subject site, although none were detected during AGI studies. Almost all large clasts and the surrounding silty coarse sand matrix were derived from a granitic source terrain. Prominent off-site exposures exhibit very intense weathering and pedogenic alteration, with reddish illuvial clay horizons and subjacent strongly cemented and very cohesive zones. The entire soil profile can be more than 8 feet thick. Older fan alluvium has unconformable erosional contacts atop both the Triassic phyllite and Cretaceous monzodiorite basement rock units in the area. Contacts with Bedford Canyon Formation rocks, however, are preliminarily interpreted as solely tectonic and not sedimentary. We believe the unit is far older than most mapped "Qof" deposits in the greater Temescal Valley, and like the underlying basement rocks we think these sediments have genetic affinity with map units in the Elsinore Basin.

Younger fan alluvium (Qyf, Holocene): Based on fault trench exposures and drilling data, up to roughly 22 feet of loose to medium dense and low-cohesion sediments are placed in a Holocene age range. An unconformable erosional contact separates the younger alluvium from yellowish older fan sediments. The unit consists of bedded silty and gravelly sand, sand, and sandy gravel derived from proximal Santa Ana Mountains bedrock sources.

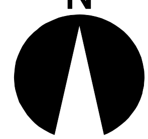
Colluvium (Qcol, Holocene): Consists of locally derived dark brown very silty sand and silty gravelly sand, deposited via slopewash and gravity creep mechanisms. Most slope toe areas can be expected to have up to 12 feet or so these low-density and porous materials present. Transitional and interfingering relationships between younger alluvium and colluvium occur near the eastern site boundary.

AGI's *Earthquake Fault Hazard* reports (AGI, 2016a; 2017) introduce a conceptual geological model for the site vicinity, supported by trenching studies, our interpreted unit correlations, and regional seismicity. The Glen Ivy South fault line is a major structural and lithologic divide between the main Santa Ana Mountains block and the disrupted band of early Mesozoic metasedimentary units, quartz-poor granitic intrusives, and Cenozoic sedimentary strata preserved along the Temescal Valley – Lake Elsinore topographic axis. Right-lateral and reverse, west-side-up offset is raising the Santa Ana Mountains block along a steeply inclined fault plane. The Glen Ivy North fault strand, usually cited as the "main" active strand of the Elsinore zone through the valley, does not appear to be accommodating significant vertical strain. Historical seismicity is far less for the Glen Ivy North fault versus the Glen Ivy South fault. Data hint that the latter is actually an independent seismic source with separate hazard potential and (likely) a different offset rate than the Glen Ivy North strand. The adjacent valley floor is tectonically subsiding relative to the mountain block and the Perris block, and probably in an absolute sense *vis-à-vis* sea level datum. The alluvial fan landform and depths of geologically young sediments on the site attest to aggrading conditions. Weber (1977) reported that a wildcat petroleum exploration well spudded close to the northwestern corner of Section 13 and less than 2,600 feet from the site did not encounter basement rock (or even pre-Quaternary sediments) before reaching a terminal depth of 1,062 feet. Late Quaternary and Holocene gravel deposits alone are hundreds of feet deep in nearby surface mining properties.

5.3 <u>Slope Stability</u>

Reconnaissance mapping found a number of examples of shallow earth failures and deeper landslides within or near APN 290-160-011. The largest features are associated with a northeast-facing slope in Bedford Canyon Formation rocks, where a coalescing series of slides has deposited brecciated materials partly atop the trace of the Glen Ivy South fault zone. Although poorly defined on Flood Control contour maps (e.g., Figure No. 8 in AGI, 2016a), at low sun angles the evacuation scars become easier to spot on aerial imagery (Figure No. 3 on the next page). Lobate

Scale as shown. APN 290-160-011 outlined in orange.
Base map adapted from Riverside County TLMA, calendar year 2011 image series.



Polyline in southeast corner of property delineates approximate headscarp crest of shallow slump-type landslides on the northeastern slope of a local ridge. Texture highlights the preferential growth of larger trees. Field estimates are that mass wasting was limited to regolith and fractured/weathered shallow bedrock extending no more than 15-20 feet below original grade. There are no signs of recent instability. Lobate toe deposits do not exit the narrow ravine at the base of the slide complex, and do not enter the proposed development area generally demarcated by residences and outbuildings.

Starred localities opposite the shallow landslide complex are very small detachment scars interpreted to have resulted from foliation plane glides. Foliation dips are south-directed in the Triassic-age metamorphic rocks. Estimated displaced volumes amount to no more than tens of cubic yards at these localities; small cones of rocky debris can be observed in the ravine below the scars.

Starred localities in the “West cut” identify small-volume brow failures developed along daylighted planar discontinuities. As long as development or recreational uses are excluded from the open space currently shown on site plans, this historic slope should not pose risks. Slope brow recession can be expected to occur indefinitely into the future, however.

AGI	**SLOPE FAILURE EXHIBIT**		
	TENTATIVE TRACT MAP NO. 37154, TEMESCAL VALLEY, CALIF.		
	PROJECT NO. 4252-SF	DATE: 1/30/17	**FIGURE 3**

breccia deposits near the slope toe are favored locations for dense vegetation and include mature (and undisturbed) oak trees. None of the slides have been interpreted to be historic. No signs of recent erosion were observed.

On the opposite side of the fault trace ravine, a pair of much smaller pop-out detachments were mapped (and are symbolically located on Figure No. 3). One failure is offsite. The drier southwest-facing slope orientation and probable higher strengths for the Triassic-age metasediments reduce mass-wasting potential for these slopes. The pop-outs could be interpreted at small block glides on south-dipping foliation planes, with one or more east-west trending joint sets acting as releasing fractures.

In the roughly cut man-made slope west of the water reservoir, one set of unfavorably oriented discontinuities has resulted in possibly three small block glide and wedge-type failures since the time of construction (symbols on Figure No. 3). The causative fractures strike north, dip moderately east, and are very rough and wavy. The cut slope also exhibits steeply southwest-dipping shears and faults. Bedford Canyon Formation rock near the shears is thoroughly altered and crumbly, with indications for (past) groundwater upwelling such as calcium carbonate crusts and iron oxide mottling of fracture fillings. The plane- and wedge-type failures involved notably weak and blocky masses along the slope brow within 6 to 10 feet of original grade.

After considering the proposed subdivision map, it is our finding and conclusion that the preceding three described areas do not pose instability threats to the housing development. No grading or utility improvements are proposed in unstable areas. Structural uses are restricted by active fault traces. Homes will be located in flat ground, and will not be vulnerable to landslide runout. Rockfall risk is nil.

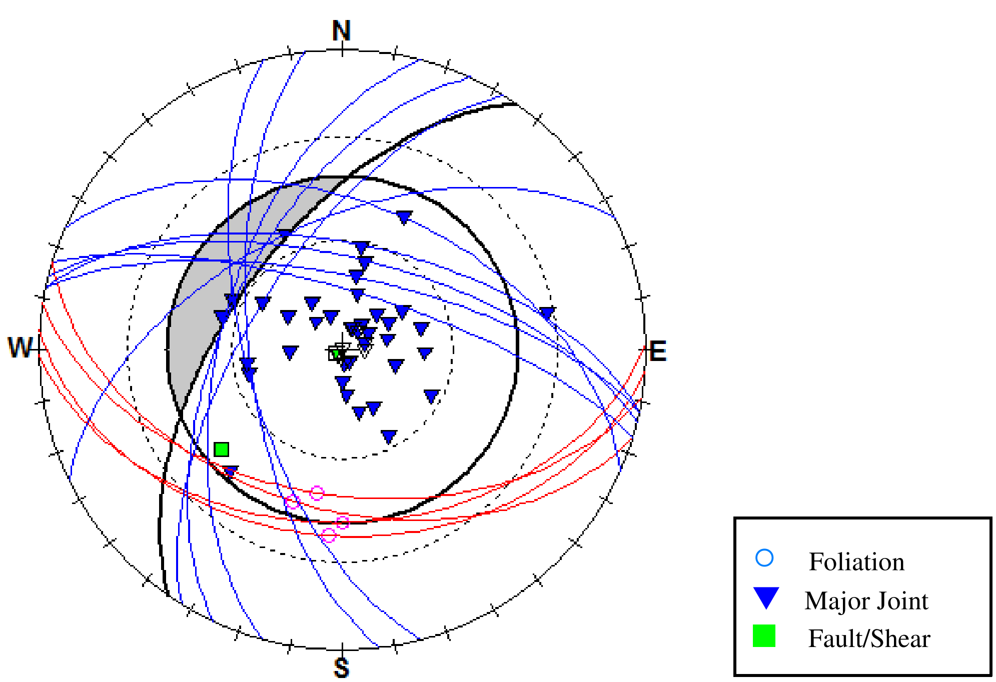
More-comprehensive kinematic analyses were applied to the existing "East cut" slope that will border Lots 1-4. The average existing slope inclination was field-measured to be approximately 59 degrees (0.66:1). The slope comprises Triassic metasediments and a smaller and much lower-height exposure of highly weathered monzodiorite. The two units are separated by a tight, near-vertical fault and a diffuse band of albite(?)-quartz rock that is probably a contact metamorphic halo. AGI manually scaled this slope of most small rocks and loose soil as part of the companion fault hazard study. The slope was digitally photographed, processed to create a scaled orthomosaic image, and formally logged. The slope has performed well for more than 40 years, and did not have any obvious past detachments or incipient threats.

Previously we have noted that the Triassic unit in the East cut consists of moderately hard to very hard, fine-grained, and thoroughly recrystallized quartzite and phyllite. The cut exposes rock classified as highly weathered (within one to three feet of original ground surfaces) to slightly weathered, with the latter judged strong. The rock mass does not have distinct compositional layering. Wavy foliation plane partings are uncommon, with mean foliation orientations near N80°W, 45-50°S dip (i.e., into-slope). A triplet of fairly distinct joint sets and common random discontinuities result in pyramidal and wedge-shaped fragments. Principal sets are oriented about N65°E, 65°SE; N75°W, 75N°; and N35°E, 55-70°NW. Joint spacing ranges from less than an inch to around 12 inches for regular sets and closer for most random and non-persistent fractures. Intact blocks are only rarely larger than a few inches across. Most joints have very narrow or tight apertures, are wavy over spans of 2 to 5 feet, and have coarse first-order asperities. The Geotechnical Map includes orientation data for "major" joints that in the judgment of the field investigator tended to be both persistent at outcrop scale and repetitive. Many measurements could be applied to closely spaced families of fractures. "Minor" or non-persistent joints were generally ignored.

A check of potential for plane and wedge failure modes in the taller, metamorphic-rock side of the as-built slope was performed using the commercial software ROCKPACK III (© C.F. Watts & Associates, Radford, Virginia). Field tilt tests established a mean friction angle for *planar* fractures and partings of about 38 degrees. The existing slope trend line of approximately N35°E was input. The data file and output plot for 51 measured joints, faults, and foliation planes utilized dip and dip direction rather than pole to plane as this convention is easier to visualize.

The dip vector stereonet plot shown below demonstrates that persistent joints have a strong bias to easterly or southeasterly dips, i.e., into slope. Foliation planes cluster fairly tightly around a south dip. Foliation strikes are at a very high angle to the cut slope trend, and therefore do not contribute to instability potential. A few northwest-dipping joints have dip vectors coincident with the great circle representing the cut slope; this is consistent with field observations that slope construction seems to have frequently relied on natural fractures as guides for the as-built inclination. No dip vectors plot beyond the cut slope great circle, thus ruling out the plane failure mode.

Intersections of great circles in the shaded critical zone highlight limited instances of at least kinematically possible wedge failure (Markland's test). The contributing joint sets are steep north-dipping fractures with a near east-west strike, and a less-common northwest-striking joint family with southwest dips. However, both sets are notably wavy, with minimal stained apertures. The latter also includes some stepped discontinuities. The implied wedge masses are thus effectively locked in place according to Hoek-Brown criteria and will not be displaced without crushing or failure of the surrounding rock.



We believe this historical slope may be safely left in place. The lower three-quarters of the slope will be erosion-resistant. However, the uppermost few feet of unit TRmu is weathered and minor nuisance sloughing of soil and small rocks is predicted. We recommend that a wide mid-slope bench be retained at the current cut-pad elevation to mitigate nuisance slough, capture runoff, and provide maintenance access. Eight feet is the minimum-recommended width, as this should allow equipment or man lifts to reach the slope face for maintenance purposes. The bench should be provided with a non-erosive surface.

New cut slopes below the bench for Lots 1-4 will encounter more-weathered materials and of course will be closer to occupied structures. The proposed 2:1 rock slopes would be judged stable. Alternative inclinations are possible but should not exceed a recommended allowable maximum of 1.5:1. Undocumented fill and any colluvium must be stripped from the proposed slopes. Section 6.8 includes guidelines for tract slope designs that in our opinion will meet qualitative and quantitative assessments of acceptable factors of safety.

Surficial *fill slope* stability was calculated according to Riverside County Transportation and Land Management guidelines modeling a 4-foot-thick saturated zone parallel to the slope surface. Internal friction and cohesion values were based on AGI laboratory tests for remolded granular and low-cohesion younger alluvium. A surficial stability factor of safety F.S. of 1.53 was obtained for a 2:1 infinite slope model, exceeding the minimum required F.S. = 1.5.

5.4 Flooding

All project areas are accorded a status of flood zone X, or outside of delineated "100-year" or 1% annual chance flood zones (FEMA, 2008). We think peak discharges from the large watershed south of the tentative tract do currently impose flooding risks, however. Consideration must also be made for what we think is high debris flow potential, especially in the event of post-wildfire conditions. Rocks greater than 3 feet across could be transported by debris flow processes, based on fault trench findings. The canyon bottom upstream of the tract has become dense with trees, which will not necessarily halt or even slow a large debris bolus and can contribute additional woody debris to rocks and mud. Fluvial sedimentation can probably occur in almost any wet year, and trenches hinted at historical sandy flood sediments up to a foot thick near existing residences. Civil drawings indicate improvements such as debris basins and headwalls are proposed for capture of canyon runoff into a large storm drain pipe passing through the tract. The capacity and protection level that will be afforded by these improvements await further design specifications.

5.5 Faulting and Regional Seismicity

The project is situated in region of active and potentially active faults, as is all of metropolitan Southern California. Active faults present several potential dangers to structures and people. Hazards associated with active faults include strong earthquake ground shaking, soil densification and liquefaction, mass wasting (landsliding), and surface rupture along active fault traces. Generally, the following four factors are the principal determinants of seismic risk at a given location:

- Distance to seismogenically capable faults.
- The maximum or “characteristic” magnitude earthquake for a capable fault.
- Seismic recurrence interval, in turn related to tectonic slip rates.
- Nature of earth materials underlying the site.

5.5.1 Fault Rupture Potential

Surface rupture presents a primary or direct potential hazard to structures built across an active fault trace. TTM No. 37154 is outside of official State of California Earthquake Fault Zones, but within a Riverside County Hazard Management Zone for active faults. As noted in the introductory paragraphs to this geotechnical investigation report, active fault traces have been identified and located by AGI within the property limits. Building setbacks from active traces have been recommended. A structural setback line is depicted on the Geotechnical Map. Areas southwest of exploration trenches FT-1, FT-2, FT-4, and ridges beyond the “West cut” were not characterized for active faults, and are included within the currently defined Restricted Use Zone unless further studies prove structural suitability. It is our opinion that the recommended setback will reduce risks to buildings and people from ground rupture hazards to below a level of significance.

5.5.2 Strong Motion Potential

All Southern California construction is considered to be at high risk of experiencing strong ground motion during a structure's design life. Due to proximity, the most likely source of damaging ground motion at the project is the Elsinore fault zone. Other, more-distant regional faults are very unlikely to produce shaking intensities as great as a large Elsinore fault zone event. However, depending upon structural design and building fundamental periods, distant-source ground motions with their lower frequency and longer durations may require special considerations. Potentially significant sources of longer-period motion would include the San Jacinto Fault near Hemet, and the San Andreas Fault where it trends through the San Bernardino Valley and San Gorgonio Pass regions. Probabilistic risk models for the Temescal Valley area assign the highest single-model contribution to hazard from a characteristic rupture along the Glen Ivy North segment of the Elsinore fault zone. The mode-magnitude event for peak ground acceleration at a 10% in 50-year exceedance risk is a M_w6.8 earthquake on this fault line (U.S. Geological Survey, 2016). Seismic source models do not include the Glen Ivy South fault as an independent source, an omission we think is ripe for further research. Regional seismicity and the characteristics of important regional fault sources are discussed more fully in the *Earthquake Fault Hazard* report (AGI, 2017).

Earthquake shaking hazards are quantified by deterministic calculation (specified source, specified magnitude, and a distance attenuation function), or probabilistic analysis (chance of intensity exceedance considering all sources and all potential magnitudes for a specified exposure period). With certain special exceptions, today's engineering codes and practice generally utilize probabilistic hazard analysis. Prescribed parameter values calculated for the 2008 U.S. national hazard model indicate the site has a 10 percent risk in 50 years of peak ground accelerations (pga) exceeding approximately 0.49g, and 2 percent chance in 50-year exposure period of exceeding 0.92g (U.S. Geological Survey, 2016b). The reported pga values were linearly interpolated from 0.01-degree gridded data and include soil correction (AGI local shear wave velocity estimate $V_{s30} \approx$ 280 m/sec in deeper sediment areas of TTM No. 37154).

Neither deterministic nor probabilistic acceleration values should be construed as exact predictions of site response. *Actual* shaking intensities from any seismic source may be substantially higher or lower than estimated for a given earthquake event, due to unpredictable effects from variables such as:

- Near-source directivity of horizontal shaking components
- Propagation direction, length, and mode of fault rupture (strike-slip, normal, reverse)
- Depth and consistency of unconsolidated sediments or fill
- Topography
- Geologic structure underlying the site
- Seismic wave reflection, refraction, and interference (basin effects)

5.5.3 Secondary Seismic Hazards

Secondary hazards include landsliding or mass wasting, liquefaction, flooding (from ruptured tanks, inundation following dam collapse, surface oscillations in enclosed water bodies, or tsunami), and unsaturated-zone subsidence as a result of dynamic soil densification. All of these induced hazards are consequences of earthquake ground motion given the right set of initial conditions.

AGI categorically rules out tsunami, seiche, tank rupture, and dam breaching hazards. The project site is inland, not adjacent to lakes or open reservoir impoundments, and not within mapped inundation pathways for embankment failures of West Dam, Saddle Dam, or East Dam at Diamond Valley Lake. Man-made Corona Lake located north of the tentative tract also poses zero hazard as it is much lower in elevation (Figure No. 1). Intervening terrain and relative elevations will protect project improvements from hypothetical failure of the Temescal Valley W.D. tank next to the northwestern corner of the property.

Temescal Valley has not yet been mapped by the California Geological Survey for State-delineated "Zones of Required Investigation" for either landsliding or liquefaction. However, landsliding, liquefaction, and subsidence susceptibility maps have been prepared for western Riverside County as a part of the County General Plan. Local safety element maps place TTM No. 37154 in "nonsusceptible" to "moderate" liquefaction potential classifications. Many aspects of AGI's field investigation were geared to evaluating liquefaction and settlement potentials in younger fan alluvium, based on site-specific estimates of historical high groundwater and soil relative densities.

Our investigation findings are that liquefaction opportunity is usually absent due to a lack of shallow groundwater. We have posited that saturated soils may on occasion be in the range of 15 to 40 feet deep, shallowing towards the canyon mouth. These episodes would be seasonal and very short-lived (days), in our opinion. Opportunity thus reflects the probability of concurrent flood-flow runoff and a major Elsinore Fault earthquake. On an annual exposure basis, this number would be very small. For the soil susceptibility part of the risk equation, data indicate the saturated zone should stay within older fan alluvium (unit Qof). Older fan deposits possess SPT N-values universally exceeding 30 at or below our high groundwater estimates. The site therefore *passes* screening criteria used to differentiate sites with liquefaction hazard from those that have no hazard (California Department of Conservation, 2008). With liquefaction potential effectively zero, other related hazards such as ground fissuring, sand boils, and lateral spread potential are also absent.

AGI finds that surface settlements from dry-sand volumetric changes should be insignificant. Using the Tokimatsu and Seed (1987) method, quantitative calculations suggest unsaturated soil seismic settlements would be up to about 0.24 inches, based on a 6.8 magnitude earthquake and a 0.49g peak ground acceleration (476-year return period). However, recommended stripping depths averaging close to 10 feet in loose-soil areas will reduce this already-low value by approximately 50 percent, or down to approximately 0.12 inches in our estimation. Differential settlements between opposite sides of residential structures should remain well under one-quarter inch.

It is our opinion that induced landslide hazard risks (collectively deep-seated landslides, shallow earth flows, slumps, or rockfall) are low. People and structures will not be vulnerable to hazards from known susceptible areas due to distance and topographical barriers. The Triassic-age metamorphic bedrock and weathered granitic rock upslope for future Lots 1-4 have high strength (from a soil mechanics point of view), and pass AGI's evaluations for mass-wasting potential along discontinuity surfaces. Brow disturbances would not be unexpected, though, based on regional experience. AGI's recommended slope terrace would capably contain the limited displaced chunks we would anticipate from a severe earthquake event.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 General

Based on the results of our field exploration, soil tests, engineering analyses, local experience, and professional judgment, it is our opinion that buildable areas beyond designated Restricted Use Zones should be suitable from a geotechnical viewpoint for the proposed residential development. Planning, design, and good construction practices will mitigate certain site constraints.

The major geological hazard imposed on buildings would be strong earthquake ground motions. Soils-related constraints are principally related to near-surface zones of loose, disturbed, and visibly porous colluvium, younger alluvium, and non-engineered fill. Deeper portions of the younger alluvium deposits and all or nearly all older fan alluvium are preliminarily accepted as competent for engineered fill support. Porous and low-density soils have been judged compressible under loads and could result in compacted fill or building settlements unless removed. All existing fills are considered unsuitable below proposed compacted-fill, building, retaining wall, and pavement improvements at the site, per the 2016 California Building Code (CBC), the 2016 California Residential Code (CRC), and AGI's investigation findings.

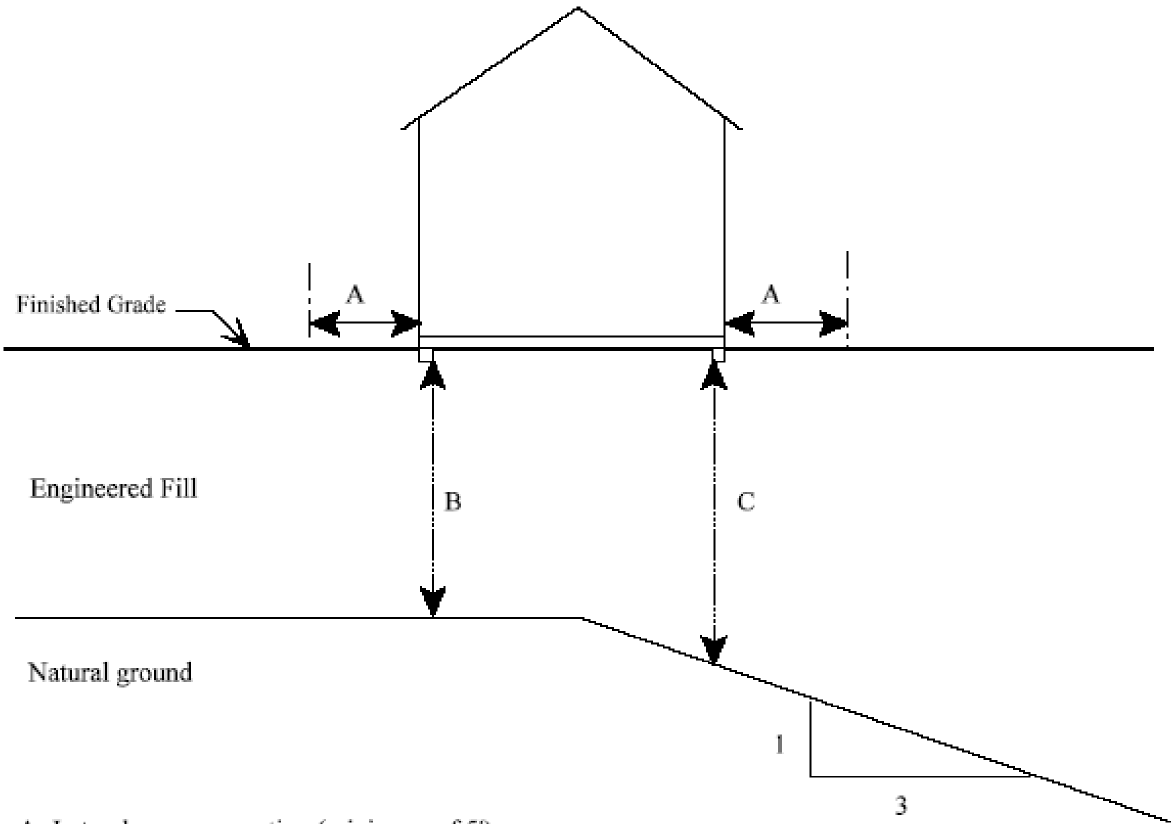
Prescriptive mitigation for the hazard of strong ground motion is nominally provided by structural design adherence to local and national building codes. On January 1, 2017, statutory adoption of the 2016 California Building Code (CBC) and 2016 California Residential Code (CRC) was effected. Section 6.10 contains recommended short- and long-period design spectral accelerations for the project.

Remedial grading is recommended to remove and replace old fills, most on-site non-engineered fault trench backfills, and compressible natural soils as engineered compacted fills. Referencing the Geotechnical Map, recommended grading should be based on the following:

- Areas mapped as unit Qyf can be expected to require an *average* of 10 feet of "removals" to achieve a competent bottom in engineered fill areas, or shallow cut areas where said materials have not been completely stripped before achieving grade. Exploration data indicate "removals" might be as little as 4½ to 5 feet close to the northeastern corner of the development, increasing to 12 feet or more in parts of Lots 1-4 where fluvial sediments grade into darker colluvium. Existing old fills were placed more or less directly atop original ground surfaces, so removal depths in existing fill areas will adjust higher by the depth of the old fill. AGI recommendations are broadly consistent with expected remedial grading in adjacent approved Tract No. 36317. Removal and recompaction should incorporate all lots, all street areas, paved flood basin access roads and road embankment fill, and structural support zones for debris basin wing walls and headwalls at the upstream ends of storm drain pipes. BMP infiltration basin(s), however, must remain untouched except as needed to create structural suitability for adjacent lots.
- All fault trench backfill at sites FT-1, FT-2, FT-4, and FT-5, whether in developed or open-space areas, should be removed and replaced as engineered fill. Trenches FT-1 and FT-2 consisted of stepped excavations featuring 5-foot-wide benches and risers, and a maximum depth of approximately 15 feet. Trenches FT-4 and FT-5 were constructed as similar benched excavations but with maximum depths of about 10 feet. Alternative geotechnical recommendations may be feasible for FT-4 should this area be considered for a stormwater BMP, pending future recommended plan reviews. AGI preliminarily accepts leaving backfill in place for the largest fault trench, FT-3, which was technically located on the neighboring property. Backfill in this trench, although permitted as a non-engineered fill, was placed with water conditioning and equipment compaction efforts, and is in AGI's view entirely suitable for conserved open space. The disturbed area was surface-rolled and lightly scarified before vegetative restoration with a hydroseed mix.

- Cut-side overexcavation equal to at least one-half the maximum fill depth at the building outline is recommended for soil-bedrock transition pads currently anticipated for Lots 1-4 (Figure No. 4, next page). Cut-fill transition lines shall be determined at bottom-of-footing elevations, and will of course vary from raw contour depictions depending upon soil removals. A maximum (benched) gradient of 3:1 shall be maintained between the deepest and shallowest fill within a building envelope. Actual required cut-side fill depths should be established during grading plan reviews and as dictated by field conditions. We recommend that the cut-side overexcavation incorporate the entire cut portion of the pad to help with drainage and landscaping, and to accommodate future structural additions. The overexcavation should not be limited solely to assumed building envelopes.
- To date, no observations of significant soil methanogenic potential have been identified on site. Animal use intensity (equestrian pens) has been low. Animal manure proportions in soil have been visually characterized as extremely low (<<2% estimated), and should be undetectable once soil overexcavation and blending are completed. The site has not been used for a dairy, poultry ranch, hog ranch, livestock feed operation, manure stockpile site, manure/livestock burial site, or run-off ponds as described in the County's *Methane Design Guidelines*. We believe methane hazard risks are effectively nil, and that further assessment is unneeded. Riverside County at its discretion, however, may require soil gas or pyrolysis tests not included in AGI's authorized scope. Unanticipated dumped manures, waste pits, or concealed organic layers found during grading should in all cases be removed to mineral soils and the unsuitable materials exported for off-site disposal.

Affiliated ownership of TTM No. 37154 with the adjacent TTM No. 37027 should ease permissions for temporary encroachment into adjacent property when performing deep removals. Both projects will benefit from elimination of a potential restricted use zone and setback line that would be created by insufficient lateral limits of soil stripping. Structural fill blankets should continue to horizontal limits represented by 1:1 subsurface projections from each lot-limit finish grade. Flood Control improvements between TTM No. 37154 and parts of Tract No. 36317 should be protected in place.



A- Lateral over-excavation (minimum of 5')
B- Thickness of fill at the shallowest
C- Thickness of fill at the deepest

The minimum fill thickness (B) beneath any building pad should be at least half of the maximum fill thickness (C). B should be a minimum of 2 feet but need not exceed 15 feet.

Reference: Riverside County Transportation and Land Management Agency, *Technical Guidelines for Review of Geotechnical and Geologic Reports* (2000). No scale.

AGI	**TRANSITION PAD SCHEMATIC**
	TENTATIVE TRACT MAP NO. 37154, TEMESCAL VALLEY, CALIF.
	PROJECT NO. 4252-SF · DATE: 1/30/17 · **FIGURE 4**

6.2 Excavatability

AGI site geological observations and equipment performance during the fault studies indicated all site soil and bedrock units should be rippable with typical dozers and large excavators. In our opinion and based on recommended mass-grading stripping depths, street alignment overexcavations to aid utility installations should not be required. However, during mass grading in younger alluvium, contractors should be prepared to handle an occasional boulder up to possibly 36 inches or so in diameter.

6.3 Site Grading

The guidelines presented below should be referenced by report title and date in the project construction specifications to provide a basis for quality control during grading. Engineered grading shall at a minimum conform to the requirements of the 2016 California Building Code (CBC), or latest adopted edition, and the Riverside County Grading Ordinance. It is recommended that all engineered fills be placed and compacted under continuous engineering observation (CBC §1705.6) and in accordance with the following:

- Demolition and removal-relocation of abandoned, hidden, or buried improvements within the limits of new construction. Solid inert features such as slabs, footings, plastic or metal pipes, and cables should be completely removed. Unreinforced clay or concrete irrigation pipes may be crushed and disposed of in site fills as long as they are crushed to a 3-inch-minus condition and placed at least two feet below planned foundations and utilities. Crushed concrete must be blended with sufficient soil to create a matrix-supported fabric than can be compacted with conventional grading equipment. Septic tanks and leach lines should be exposed and fully removed to undisturbed materials. Permitting and agency observation of septic tank removals is required by the Riverside County Environmental Health Department. Open cesspools or seepage pits should be backfilled with lean concrete slurry mix (CLSM). Representatives of AGI should perform observations of all site demolition work on an as-needed basis to document the nature and depths of buried improvements as they are removed.

- Well closure: If the on-site well is not intended to be retained in working condition, it should be properly grouted, sealed, and capped by a C57-licensed drilling contractor in accordance with Riverside County and State DWR regulations. A copy of the well closure report must be submitted to AGI.

- Clearing, grubbing, and disposal of trees and tree stumps, woody vegetation, and hidden debris should be initiated prior to grading. Seasonal weeds or grasses should be scraped aside if especially dense. Trace amounts of dry grasses may be finely comminuted and mixed with stripped soils. Should animal manures be found in any stockpile or concentrated as layers in site soils, these organic materials must be collected for off-site disposal. Manure shall not be blended into site engineered fill. If necessary in the opinion of the Geotechnical Engineer, the grading contractor must be prepared to supply personnel to pick roots or debris from engineered fill during the grading operations.

- Pre-watering would be advised if mass grading takes place during the seasonally dry months. Ideally, moisture should be available to the upper 8 to 10 feet of material.

- Excavation of unsuitable native soil and undocumented fill as determined at the time of grading by the Geotechnical Engineer shall be performed as discussed in Section 6.1 for support of new compacted engineered fill, structures, and street improvements. Recommended excavation "bottoms" shall consist of undisturbed bedrock, or older fan alluvium, or qualified younger alluvium. Excavation bottoms should be free of live or dead tree roots larger than ½-inch diameter. Acceptance will be by geological observation, probing, and density testing in alluvium. Alluvial bottoms (units Qyf and Qof) shall demonstrate in-place dry densities of 85% or greater of the laboratory-determined maximum dry density to be accepted, and exhibit insignificant macro-porosity. All of the site soils should be suitable for re-use in new engineered compacted fill if free from organic debris, and trash. Oversize rock fragments (diameter ≥12 inches) should be segregated and either placed in deeper fills per recommendations for "soil-rock" fill (see below), or set aside for alternative disposal options. Final determinations of removal depths shall be made during grading based upon conditions encountered during earthwork activities.

- Observation and acceptance of all stripped areas by the Geotechnical Engineer and/or Engineering Geologist prior to placing fill.

- Scarification of exposed excavation bottoms to a depth of 6 to 10 inches (or as field conditions dictate), moisture-conditioning by adding moisture or drying back to above-optimum moisture contents as described below, and recompaction to at least 90 percent of the maximum dry density as determined by the ASTM D1557-12 test standard.

- Where fill is to be placed on slopes inclined at 5:1 or steeper, deep benching should be performed every three to four-foot rise in fill elevation as the new fill is placed.

- Fill soils should be uniformly moisture-conditioned by mixing and blending to optimum water content or higher, and placed in lifts having thicknesses commensurate with the type of compaction equipment used, but generally no greater than 6 to 8 inches. *Fill water contents below the recommended minimum water content shall constitute a basis for non-acceptance of the fill irrespective of measured relative compaction, and at the discretion of the Geotechnical Engineer may require the fill be reworked to produce uniform water contents at or over the desired 100% of optimum moisture.*

- The contractor should utilize means and methods that will produce uniform compaction of soil fill to at least 90 percent of the laboratory maximum dry density determined according to the ASTM D1557-12 standard. Compaction may be supplied by earthmoving equipment, or specialty compaction tools.

- “Soil-rock” fills may be constructed to dispose of boulders individually. We expect that hard and durable boulders will pop up in Qyf excavations. Oversize rock can optionally be removed from the site, crushed to 6-inch-minus fragments and mixed with regular soil fill, used for channel or dissipator rip-rap, or spoiled into deep fill. Boulders can also be saved for use as landscape rock if desired (not on slope faces). A slight chance exists of finding angular and highly weathered granitic boulders in unit Qof, but we predict that little if any excavation will actually occur in this unit. The weathered boulders would likely be crushed by heavy grading equipment. We expect the easiest disposal option will be individual placement in deep fill. Adequate space must be allowed beside rocks to allow compaction equipment to pass on all sides. Individual rocks shall be placed at least **10** feet below finish grades and at least **10** feet horizontally from slope faces. Mechanical soil compaction around rocks must be observed by AGI professional or technical staff.

- Field observation and testing shall be continuously performed to verify that the recommended compaction and soil water contents are being uniformly achieved. Where compaction of less than 90 percent is indicated, additional compaction effort, with adjustment of the water content as necessary, should be made until at least 90 percent compaction is obtained. Field density tests should be performed at frequencies not less than one test per 2-foot rise in fill elevation and/or per 1000 cubic yards of fill placed and compacted at this project.

- Preliminary information is that TTM No. 37154 will be a balanced site. If plans change and import material is needed, however, then import soil should consist of a coarse-grained granular soil classification as defined by the Unified Soil Classification System, meet the definition of a Group I soil per Table R405.1 of the 2016 CRC, have very low expansion potential (specifically, an expansion index value of under 20), and be free of deleterious organic matter and large rocks. The borrow site and derived import soils must be reviewed and accepted by the Geotechnical Engineer prior to importation and use. Geotechnical qualification of import materials may require laboratory materials testing, and adequate time must be allowed for this to proceed. Owners should also consider contaminant screening by a properly qualified environmental laboratory for certain persistent chemical pesticides, if any import source was previously used for orchard cultivation.

- Proper surface drainage should be carefully taken into consideration during site development planning. Pad precise grading should incorporate berms, V-swales, or other means to prevent runoff from overtopping cut or fill slopes. Brow ditches are recommended at the crest of all (new) cut slopes intercepting ascending ground beyond the slope. The Geotechnical Map shows a recommended conceptual bench above Lots 1-4 that we think will adequately catch runoff and small rocks shed from the historical slope to the southeast. We think the latter slope is best left untouched. Finish pad surface contours should result in drainage being directed away from the buildings. Storm water management utilizing low impact development (LID) concepts will be required by building authorities. We would predict good infiltration capability in younger fan alluvium, considering soils classifications and preliminary infiltration test data from adjacent TTM No. 37027 (AGI, 2016c). Water infiltration testing in TTM No. 37154 was not in the current work scope, but is recommended once the sizes and depths of infiltration BMPs (basins or filter trenches) have been established. Infiltration-type BMPs are not recommended for engineered fill.

- We believe blended site soils will have negligible expansion potential. It is recommended that expansion index testing verify the predicted conditions upon completion of rough grading in the future pad areas. The exact number of tests should be determined by site observations made during grading, but should not be less than approximately one test per 3 lots (4 tests total) plus one test per additional on-site or import soil type. If tests indicate an expansion index of 20 or higher, then plasticity index tests are recommended to ascertain needs for foundation deepening or concrete slab-on-grade stiffening, subgrade pre-saturation, or other means of limiting soil water content changes during and after construction.

6.4 Earthwork Volume Adjustments

Removal and recompaction of the existing fills and surficial younger alluvium will result in material volume loss in the range of 15 to 18 percent, in our estimation. A zero bulking factor should be assumed for expected shallow bedrock cuts. Finally, average compaction subsidence of 0.2 foot under the action of heavy equipment would be a suitable and conservative estimate for all soil-unit bottoms. The calculation of earth balance factors for the project as a whole will be subject to some uncertainty, based on the types of materials encountered to create planned pad grades and the achieved degrees of compaction. AGI expects any minor on-site volumetric discrepancies will be remedied by changes to as-built pad elevations.

6.5 Subdrains

Based on the current project plans, expected removals, and underlying geology, AGI believes subsurface drainage devices such as canyon subdrains and slope keyway heel drains should not be required in TTM No. 37154. It is imperative that recommended intermediate grading plan reviews confirm or modify this preliminary opinion. Design details would be based on burial depths, drain lengths, functional type, and other local site characteristics. Final evaluations for siting and elevations of subdrains will occur in the field during grading.

6.7 Slopes

AGI expects new slopes of up to roughly 26 feet high within the project. We recommend that permanent manufactured slopes be designed and built according to the bullet points below:

- All fill slopes should be designed at maximum slope inclinations of 2:1 (H:V).
- Fill slopes should be compacted as generally recommended under Site Grading, and surfaces should be free of slough or loose soils in their finished condition. Fill compaction to 90 percent relative compaction or better at the slope face should be verified by appropriate testing. Vertical track-walking with dozers is the preferred finishing method as this best management practice slows the development of erosional rills and gullies. It is our opinion that fill slopes designed and built to this standard using on-site materials will be globally and surficially stable. Because fills and pad fill slopes will entail deep removals significantly below proposed finish grades, shear keys will not be required.
- Cut slopes in younger fan alluvium should be reconstructed as stabilization fill slopes, with minimum dimensions as shown on the grading detail included in Appendix B. This recommendation will be pertinent to proposed slopes bordering the western side of the development area along Towhee Lane.
- Lots 1-4: Cut slopes 26 feet or less in height are proposed below an AGI-recommended bench, the latter starting near Elev. 1445 and sloped to drain toward the south (see Section 5.3 and Plate No. 1). The bench would actually

be a narrow preserved strip of the existing bedrock cut. New descending slopes will intercept weathered monzogranite, phyllite, and quartzite. Analyses indicate the new slopes should be stable and should perform satisfactorily at inclinations up to a 1.5:1 maximum recommended inclination. The proposed 2:1 slopes are preferable. Flatter slopes are easier for homeowner maintenance and for landscaping, although in our opinion plant materials will be difficult to establish on any tract rock slopes.

- Brow ditches are recommended for all new cut slopes that intersect ascending adjacent ground. If regulatory authorities concur, we think existing historical cut slopes will perform better if left untouched with retention of existing mature chaparral.
- Should any soil slope steeper than 3:1 *and* taller than 30 feet be proposed, then the slope should be analyzed by AGI for global stability. Any new bedrock slope, other than cuts already evaluated within or next to Lots 1-4, should be separately analyzed and verified as stable regardless of height, if steeper than 2:1.
- Erosion control measures should be implemented for all completed slopes as soon as practicable, per applicable Riverside County ordinances.

6.7 Foundations and Slabs-on-Grade

Although information regarding anticipated foundation loads was not available for this report, imposed loads for residential construction two stories or less in height are generally low to moderate. Foundation plans, once they become available, must be evaluated by this firm for compatibility with following preliminary recommendations.

Conventional shallow continuous or spread footings embedded entirely within compacted engineered fill appear feasible for the project site. Preliminary designs may be based on an allowable net bearing value of 2,000 pounds per square foot for the recommended minimum foundation widths and embedments. This value may be increased by one-third when accounting for short-duration seismic or wind loads.

Lateral load resistance will be provided by friction between the supporting materials and building support elements, and by passive pressure. A friction coefficient of 0.35 may be utilized for foundations and slabs constructed atop bedrock or compacted granular structural fill. A passive earth pressure of 250 pounds per square foot, per foot of depth, to a maximum of 2,500 pounds per square foot may be used for the sides of footings. When combining passive pressure and frictional resistance, the passive pressure component should be reduced by one-third.

Based on the findings of this report, future soil expansion index values would be unlikely to exceed the categorically "very low" range of 0 to 20. The following preliminary foundation design recommendations will be applicable for expansion indices of under 20, for soils in the top five feet below as-built finish grades. Recommendations by the project's structural engineer or architect that exceed the soils engineer's recommendations should take precedence over the following minimum-recommended requirements. Final foundation and building slab design must be checked against the expansion potential and/or plasticity index of the as-built pad soils at the conclusion of grading. Foundation design comes under the purview of the structural engineer, and the guidelines presented below are recommendations to withstand the expected soil pressures only, without consideration of structural loads, details, and usage.

Columns should be supported on spread footings or integrated footing and grade beam systems. Column loads should not be supported directly by slabs. All exterior isolated footings should be tied in at least two perpendicular directions by grade beams or tie beams to reduce the potential for lateral drift or differential distortion. The base of the grade beams should enter the adjoining footings at the same depth as the footings (viewed in profile). The grade beam steel should be continuous at the footing connection. When designing interior footings, the Structural Engineer should consider utilizing grade beams to control lateral drift of isolated column footings, if the combination of slab restraint, friction, and passive earth pressure will not be sufficient to resist lateral forces.

- Continuous exterior footings should be founded at minimum depths not less than 12 inches below the lowest adjacent ground surface for one- or two-story buildings where roof live loads remain 30 psf or less and soils are non-expansive (Figure R403.1.3 of the 2016 CRC). Continuous interior footings may be founded at a minimum depth of 12 inches below the lowest adjacent ground surface (= top of slab). These minimums apply to level ground. Footing widths shall be as specified by Table R403.1(1) of the CRC for the proposed construction type and number of floors, but not less than 12 inches.

- All strip footings cast monolithically with concrete slabs-on-grade should have at least (a) One No. 4 reinforcing bar placed near the top and one No. 4 reinforcing bar placed near the bottom of each footing; *or* (b) One No. 5 bar in the middle third of the footing depth; *or* (c) Two No. 4 bars in the middle third of the footing depth (CRC §R403.1.3.3).

- All interior concrete slabs-on-grade must be underlain with a vapor retarder consisting of a minimum 6-mil-thick plastic membrane (10-mil products such as StegoWrap™ are optional but preferred for their resistance to damage and lower vapor transmissivity). Ends shall be overlapped a minimum of 6 inches in each direction and sealed. Sub-slab membranes should be covered with a minimum of two inches of moistened sand to help prevent punctures and to aid in uniform concrete curing.

- The design engineer should determine the actual thickness of concrete floor slabs based upon proposed loading and use. Plain concrete is not recommended. AGI recommends specification of at least No. 3 bars at 18 inches on-center each way for monolithic slab-on-grade construction. Reinforcement shall be supported to remain in place from the center to upper one-third of the slab for the duration of the concrete placement (CRC R506.2.4). It is further recommended that residential building slabs-on-grade be at least 4.0 inches thick.

- Pre-placement saturation testing below concrete slabs and flatwork may be waived for this project as long as only site soils, or select import materials with verified expansion index values under 20, are used for grading.

6.8 <u>2016 California Building Code Seismic Criteria</u>

Prescriptive mitigation for the hazard of strong ground motion is nominally provided by structural design adherence to local adopted building codes. The 2016 California Building Code (CBC, based on the 2015 *International Building Code*) maintains the previous code's "look-up" convention for seismic engineering, using as primary inputs the site's location and the assigned site class. The latter is a measure of "stiffness" determined by borehole tests or geophysical methods. The 2016 code explicitly incorporates seismic risk calculated from the probabilistic 2008 National Seismic Hazard model and newer attenuation functions. Design coefficients are ultimately functions of distance to active faults, fault activity, and measured or correlated mean shear wave velocity within 30 meters (~100 feet) of the ground surface. The tabulated criteria presented below were derived in accordance with the rules of Section 1613 of the 2016 CBC and ASCE/SEI Standard 7-10. Site coordinates used for our analysis reflect the closest site-to-source distance based on the model source, i.e., the Glen Ivy North fault segment.

Table 6.8-1
2016 CBC Seismic Design Factors and Coefficients
(Lat. 33.73760, Long. 117.46246)

2016 CBC Section #	Seismic Parameter	Indicated Value or Classification
1613.3.1	Mapped Acceleration S_s	2.314g (Note 1)
	Mapped Acceleration S_1	0.920g (Note 1)
1613.2.2	Site Class	D (Note 2)
1613.3.3(1)	Site Coefficient F_a	1.0
1613.3.3(2)	Site Coefficient F_v	1.5
1613.3.3	Adjusted MCE Spectral Response S_{MS}	2.314g
	Adjusted MCE Spectral Response S_{M1}	1.381g
1613.3.4	Design Spectral Response S_{DS}	1.543g (Note 3)
	Design Spectral Response S_{D1}	0.920g (Note 3)

(1) Interpolated from 0.01-degree gridded data in the probabilistic 2008 National Seismic Hazard Model (U.S. Geol. Survey, 2017b), 2% in 50-year exceedance probability.
(2) Based on proposed site grading, borehole SPT data, and estimated $V_{s30} \approx 280$ m/sec.
(3) Defined by 2016 CBC §1613.1 and the statement of ASCE/SEI 7-10 §21.2.3 indicating site-specific MCE response spectral acceleration at any period shall be taken as the lesser of the probabilistic or deterministic spectral response accelerations, with the latter subject to stated lower-limit values. The design spectral response accelerations are calculated as ⅔ of the MCE value.

Table R301.2.2.1.1 of the 2016 CRC specifies a Seismic Design Category of **E** for residential buildings sited where S_{DS} > 1.25g. However, alternative assignment to design category **D_2** is allowed for housing meeting certain structural design restrictions (ref. §R301.2.2.1.2 of the code). The site-modified zero-period MCE_R ground motion estimate PGA_M is 0.910g. Seismic response coefficients determined by the USGS tool from Figures 22-17 and 22-18 of ASCE 7-10 would be:

$C_{RS} = 0.920$ $C_{R1} = 0.907$

Owners are reminded that the 2016 CBC/CRC and related building codes define minimum criteria needed to produce acceptable life-safety performance. Code-compliant structures can still suffer damage. Additional building resistance features can be added to further limit earthquake damage, sometimes for modest cost premiums. Ultimately, final selection of design coefficients should be made by the building engineer based on local guidelines and ordinances, expected structural response, and desired performance objectives.

6.9 Pavements

The following table presents a *sample* structural section for residential roadway asphalt pavement based upon Caltrans design methods, a 20-year pavement lifetime, and assumed soil R-values. This information may be useful for budget cost estimates. Final recommended sections may change and should be based on expected loading, desired pavement lifetime, and recommended soil R-value tests performed per Caltrans Test Method 301 after the as-built subgrades can be sampled.

Table 6.9-1
Preliminary Conventional Asphalt Pavement Design

Location	Traffic Index (1)	R-Value (2)	A.C. Thickness	Base Thickness (3)
Local Interior Street, TTM No. 37154	5.5	50	3.0"	6.0"

(1) Traffic indices per Riverside County Standard No. 114 and planned surfaced widths.
(2) Caltrans design maximum-allowed R-value. Estimated R-values for engineered fill derived from site alluvial units would be 60 or higher.
(3) Aggregate base material meets specification for Caltrans Class 2 ABM, R-value $\geq$78.

AGI recommends the uppermost 12 inches of soil subgrade materials below pavement or curb-and-gutter installations be processed and compacted to a minimum of 95 percent of the laboratory maximum dry density determined by ASTM D1557-12. Curb-and-gutter concrete should rest on prepared soil subgrades and not crushed-rock base courses. We have found far too many instances of base courses becoming preferred pathways for landscape water to enter the pavement structural section and cause premature failure. Base materials should meet specifications for Caltrans Class 2 aggregate base material or better, and should be placed and fully compacted in lifts no greater than 6 inches thick to a minimum dry density of 95 percent of the laboratory maximum dry density per the ASTM D1557-12 standard. Pavement gradients should be designed to direct stormwater runoff to concrete flowlines or gutters.

6.10 Retaining Walls

The available tentative tract plans depict several retaining walls. Preliminary recommended earth pressure values for prospective walls are presented in the following table. It has been assumed that well-drained sandy alluvial soil with a sand equivalent value of 30 or better would be utilized for backfill. On-site younger fan alluvium meets these criteria. Additional wall pressures from vehicle or building surcharges and seismic inertial loads should be added to the stated values when needed. The latter may be based on a peak ground acceleration of 0.49g (475-year return period) and event magnitude M_w6.8. Other expected site conditions such as drained, granular backfill soils appear to be consistent with the assumptions of the widely used Mononobe-Okabe method or similar later variations of rigid plastic methods for finding earthquake force magnitudes on walls. Standard reduction factors for pga (e.g., 0.5 for M-O method) may thus be implemented.

Table 6.10-1
Retaining Wall Equivalent Fluid Pressures

Inclination of Retained Material	Equivalent Fluid Pressure (psf) On-site soils with Φ ≥ 29.5°	
	Unrestrained	Restrained
Level	43	63
2:1	75	80

Wall backfill should be mechanically compacted to a minimum of 90 percent relative compaction. Density testing is recommended to verify the adequacy of compaction. Walls greater than 3 feet in height should be provided with either a continuous perforated subdrain line embedded in open-graded crushed rock placed at the inside bottom of the wall, or open masonry head joints, or weepholes.

Site materials are believed to be suitable for MSE-type systems with architectural wall facing elements (e.g., Keystone, Redi-Rock big blocks, etc.) and a geogrid-reinforced soil mass. If optional MSE walls are selected, AGI recommends site- and structure-specific geotechnical reviews that at a minimum include global stability analyses, plus recommendations for foundation base layers, soil backfill, selective grading, and drainage.

6.11 Temporary Sloped Excavations

Construction excavations at the site after mass grading are expected to remain within soil units and not bedrock (i.e., low-cohesion younger fan alluvium, dense older alluvium, or compacted engineered fill). Excavations up to 5 feet in depth in compacted fill should stand vertically for temporary periods. Trenches in loose fan alluvium, trenches open for any extended period of time, and all manned excavations greater than 5 feet in depth should be properly sloped or shored. Where sufficient space is available for a sloped excavation in fill or yellowish-colored older alluvium, the side slopes should be inclined to no steeper than 1:1 (horizontal to vertical) per current OSHA rules for excavation material Type B and an excavation depth of 20 feet or less. Storm drains are the likeliest features to encounter younger alluvium, and open unshored cuts should be designed at 1½:1 for material Type C. We would expect trench boxes to be a suitable alternative protection measure. The exposed earth materials in temporary excavation side slopes should be observed and verified as representative for the specified inclinations by a geotechnical engineer. The exposed slope faces should be kept moist and not allowed to dry out.

Surcharge loads should not be permitted within five feet from the top of excavations, unless the cut or trench is properly shored. Contractors are ultimately responsible for verifying that slope height, slope inclination, excavation depths, and shoring design are in compliance with Cal-OSHA safety regulations (Title 8, Section 1540-1543 *et seq.*), or successor regulations.

6.12 Trench Backfill

All soil-backfilled utility trenches in the tract should be backfilled in layers and mechanically compacted to at least 90 percent of the laboratory maximum dry density determined by ASTM D1557-12. Flooded or jetted backfill is not recommended except for densification of select granular bedding materials placed directly around utility conduits. Testing has indicated that shallow unit Qyf alluvial soils should meet the minimum sand equivalent ≥30 required by most pipe-zone backfill materials specifications. Accordingly, Qyf-derived soils are preliminarily accepted for bedding and initial backfill purposes. Screening could be needed to remove larger rocks. Additional sand equivalent tests of representative materials are recommended during construction. Density testing is recommended to verify backfill compaction adequacy.

For storm drain pipes and manholes that will be dedicated to Riverside County, we recommend bedding material and placement conform to the requirements of the latest adopted edition of the Standard Specifications for Public Works "Greenbook" §306-6 and the Riverside County Flood Control and Water Conservation District standard drawing Number M815. Foundation zone preparation for RCP drain pipes should include a minimum of 4 inches of mechanically densified sand bedding material in the normal, unsaturated native-ground condition. Bedding material above the foundation zone should consist of well-graded sand with a minimum sand equivalent value of 30 (e.g., unit Qyf materials, screened to remove particles >2.5

inches across or larger per Greenbook §217). At least 12 inches of bedding material is recommended laterally at pipe springline elevations and as a minimum coverage depth over the top of the pipe.

Based on visual-manual tests and observed textures, all site alluvium should be adequately permeable to allow jetting of select bedding material above RCP foundation zones. Equipment and procedures to densify bedding should be in conformance to "Greenbook" sections §306-6.5.1 and §306-12.4. Jet pipe insertion intervals should be of a frequency adequate to eliminate all voids from the pipe haunch zone, but no greater than 3 feet, contiguous along each side of the RCP. Recommended alternatives to jetted bedding-zone backfill would be mechanically compacted bedding material (Greenbook §306-12.3), or substitution of "controlled low strength materials" (CLSM, e.g., flowable fill) for sand bedding. For CLSM there are particular procedures for backfill staging in order to prevent pipe flotation, which should be addressed by the project civil engineer if this option is exercised.

Properly compacted regular site soils will be acceptable for unrestricted backfill over storm drains per Riverside County standard drawings. Unrestricted trench backfill should begin one foot or more above the pipe and extend to the planned pavement subgrade. All excavated local soils and granular import soils free of large rocks and any deleterious organic wastes should be geotechnically suitable for unrestricted regular trench backfill. Latest-edition "Greenbook" specifications in Table 217-2.2 would be recommended for classification of oversize particles. Rocks up to 6 inches in diameter would be acceptable in regular trench backfill as long as they were fully surrounded by compacted soil matrix. AGI would recommend rocks larger than 2½ inches in any dimension be excluded from fill placed within one foot of pavement subgrades. Sufficient compactive effort shall be maintained to obtain uniform compaction of at least 95 percent of the laboratory maximum dry density, determined according to the ASTM D1557-12 standard, for all storm drain soil fill within 3.0 feet of finish street subgrade (RCFC & WCD requirement).

6.13 <u>Soil Corrosivity</u>

Chemical analyses were performed to provide a cursory evaluation of the corrosivity of the future fill soils. Tests were selectively performed on dark colluvium and shallow recent alluvium, materials that in our experience sometimes have elevated aggressiveness to concrete and metal due to humic acids and past agricultural practices such as fertilizer applications. Determinations included soluble sulfate, soluble chloride, pH, and minimum saturated resistivity. Colluvium had very low soluble salts, a slightly acidic pH of 6.4, and minimum saturated resistivity of 4,400 ohm-cm. Younger site alluvium also tested very low for sulfate and chloride, had a typical near-neutral pH of 7.3, and high resistivity of 12,000 ohm-cm. Neither material should be aggressive to concrete, but colluvium-derived fill would potentially be corrosive to mild steel. Colluvium will be a very small proportion of total earthwork, though, and we predict final site soils will be very uniform after mass grading removals and blending. A qualified corrosion engineer should be consulted for a more in-depth evaluation of soils effects on buried ferrous objects and for any special corrosion protection design that may be required.

Normal Type I-II cement should be suitable and is preliminarily recommended for concrete mix designs utilized for this project, based on American Concrete Institute (ACI) 318 Table 4.3.1. Additional sulfate tests are recommended in the as-built engineered fill. Generally, an aliquot of each finished-pad expansion index soil sample should be tested for soluble sulfate. Type V cement may optionally be used for any site concrete mix, and would be mandatory for measured sulfate concentrations exceeding 0.20 weight percent. It is recommended that all concrete which will come in contact with on-site soil materials be selected, batched, and placed in accordance with the latest California Residential Code and ACI technical recommendations.

6.14 Construction Observation

The preliminary foundation recommendations presented in this report are based on the assumption that all structural foundations will bear solely within properly compacted engineered fill approved by this office. It is recommended that all engineered fill placement operations be performed under continuous engineering observation and testing by AGI personnel. Continuous observation is a 2013 CBC requirement for engineered fill. Verification testing of completed soil-subgrade expansion potential, soluble sulfate content, and soil plasticity index (if applicable) is recommended at appropriate points in the development time line. The foundation excavations should be observed prior to placing reinforcing steel to verify that the footings will be embedded within satisfactory materials, the excavations are free of loose or disturbed soils, and the design depths have been achieved.

6.15 Investigation Limitations

The present findings and recommendations are based on the results of surface reconnaissance combined with interpolations of soil and rock conditions between a limited number of subsurface explorations. The nature and extent of variations beyond or between the explorations may not become evident until construction. If conditions encountered during construction vary significantly from those indicated by this report, then additional geotechnical tests, analyses, and recommendations may be required from this office. Because this report has also incorporated assumed conditions or characteristics of the proposed improvements where specific information was not available, grading plan and foundation plan reviews by this firm are recommended prior to site grading in order to evaluate the proposed construction from a geotechnical viewpoint and allow modifications to the preliminary recommendations developed to date. This report and subsequent plan review reports should be referenced by title and date on final site grading plans by the project civil engineer as a part of the overall project specification. Lastly, a pre-construction meeting with the owner, grading contractor, and civil engineer is strongly encouraged to present, explain, and clarify geotechnical concerns, uncertainties, and recommendations for the site.

7.0 CLOSURE

This report was prepared for the use of the project principals The Highlands at Sycamore Creek LLC and their designated parties in cooperation with this office. All professional services provided in connection with the preceding report were prepared in accordance with generally accepted professional engineering principles and Southern California practice in the fields of soil mechanics, foundation engineering, and engineering geology, as well as the general requirements of Riverside County in effect at the time of report issuance. We make no other warranty, either expressed or implied. We cannot guarantee acceptance of the geotechnical report by regulating agencies without needs for additional services outside of our authorized scope and costs.

We are pleased to have been trusted with the opportunity to help engineer Tentative Tract No. 37154. Questions concerning geotechnical findings and recommendations should be directed to the undersigned at our Riverside office at (951) 776-0345.

Respectfully submitted,
Aragón Geotechnical, Inc.

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Attachments: Appendix A, Map Explanation & Field Boring Logs
Appendix B, Laboratory Testing; Grading Details; Stability Models
Plate No. 1, Geotechnical Map (in pocket)
CD-ROM with this report in .pdf format

Distribution: (4) Addressee

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Riverside County Flood Control & Water Conservation District Archive

Date Flown	Flight Number	Scale	Frame Numbers
1-30-62	1962 County	1:24,000	Line 3, Nos. 460-462
6-20-74	1974 County	1:24,000	Nos. 506-508
4-14-80	1980 County	1:24,000	Nos. 638-540
1-20-84	1984 County	1:19,200	Nos. 944-945
3-21-90	1990 County	1:19,200	Line 11, Nos. 4-6
1-30-95 2-1-95	1995 County	1:19,200	Line 10, Nos. 9-11 Line 11, Nos. 6-8
3-18-00	2000 County	1:19,200	Line 11, Nos. 4-12
4-14-05 8-2-05	2005 County	1:19,200	Line 10, Nos. 9-12 Line 11, Nos. 4-6
3-28-10 3-29-10	2010 County	1:19,200	Line 10, Nos. 9-12 Line 11, Nos. 4-6

Google Earth Pro Historical Image Archive

Image dates as shown in application:

9/29/96	1/11/07	1/8/13
6/5/02	6/5/09	11/12/13
12/31/02	11/15/09	4/27/14
12/31/04	3/9/11	2/9/16
1/30/06	6/7/12	10/21/16

APPENDIX A

A P P E N D I X A

GEOTECHNICAL FIELD STUDY PROTOCOL & FIELD BORING LOGS

The Geotechnical Map (Plate No. 1 in pocket) was prepared based upon information supplied by the client, or others, along with Aragón Geotechnical's field measurements and observations. Exploratory fault trench locations illustrated on the map exhibit were based on precision survey points, and are considered exact. Soil boring locations were derived from paced and taped measurements of distance to existing improvements or prominent natural features, and should be considered approximate.

The Field Boring Logs on the following pages schematically depict and describe the subsurface (soil and groundwater) conditions encountered at the specific exploration locations on the date that the explorations were performed. Unit descriptions reflect predominant soil types; actual variability may be much greater. Unit boundaries may be approximate or gradational. Text information often incorporates the field investigator's interpretations of geologic history, origin, diagenesis, and unit identifiers such as formation name or time-stratigraphic group. Additionally, soil conditions between recovered samples are based in part on judgment. Therefore, the logs contain both factual and interpretive information. Subsurface conditions may differ between exploration locations and within areas of the site that were not explored. The subsurface conditions may also change at the exploration locations over the passage of time.

The investigation scope and field operations were conducted in general accordance with the procedures recommended by the American Society for Testing and Materials (ASTM) standard D420-98 entitled "Site Characterization for Engineering Design and Construction Purposes" and/or other relevant specifications. Soil samples were preserved and transported to AGI's Riverside laboratory in general accordance with the procedures recommended by ASTM standard D4220 entitled "Standard Practices for Preserving and Transporting Soil Samples". Brief descriptions of the sampling and testing procedures are presented below:

Ring-Lined Barrel Sampling – ASTM D3550-01

In this procedure, a thick-walled barrel sampler constructed to receive thin-wall liners (usually a stack of 1-inch-high brass rings) is used to collect "relatively undisturbed" soil samples for classification and laboratory tests. Samples were attempted at selected depths in soil materials within 15 to 25 feet of the ground surface. The drilling rig was equipped with a 140-pound mechanically actuated automatic driving hammer operated to free-fall 30 inches, acting on rods. A 12-inch-long sample barrel fitted with 2.50-inch-diameter rings and tubes plus a waste barrel extension was subsequently driven a distance *of 18 inches or to practical refusal (considered to be ≥50 blows for 6 inches). The raw blow counts for each 6-inch increment of penetration (or fraction thereof) were recorded and are shown on the Field Boring Logs. An asterisk (*) marks refusal within the initial 6-inch seating interval. The hammer weight of 140 pounds and fall of 30 inches allow rough correlations to be made (via conversion factors that normally range from 0.60 to 0.65 in Southern California practice) to uncorrected Standard Penetration Test N-values, and their correlative descriptions of consistency or relative density. Ring samples fit directly into many laboratory test instruments without additional handling and disturbance.*

Standard Penetration Tests – ASTM D1586-11

In the deeper portions of each soil boring, Standard Penetration Tests were performed to (1) Recover periodically spaced, disturbed samples suitable for classification; (2) Screen the site for shallow groundwater; and (3) Help derive a seismic site class. A split-barrel sampler with a 2.0-inch outside diameter is driven by successive blows of a 140-pound hammer with a vertical fall of 30 inches, for a distance of 18 inches at the desired depth. The drill rig used for this investigation was equipped with an automatic trip hammer acting on drilling rods. The total number of blows required to drive the sampler the last 12 inches of the 18-inch sample interval is defined as the Standard Penetration Resistance, or "N-value". Penetration resistance counts for each 6-inch interval and the raw, uncorrected N-value for each test are shown on the Field Boring Logs. Drive efficiencies for automatic hammers are higher than older rope-and-cathead systems, which have mostly disappeared from practice. Where practical refusal was encountered within a 6-inch interval, defined as penetration resistance ≥50 blows per 6 inches, the drive was halted and the raw blow count recorded for the noted fractional interval; an asterisk (*) marks refusal within the initial 6-inch seating interval. N-values are undefined for drives of less than 18 inches, but would normally be greater than 50. The N-value represents an index of the relative density for granular soils or comparative consistency for cohesive soils.

Bulk Sample

A relatively large volume of soil is collected with a shovel or trowel. The sample is transported to the materials laboratory in a sealed plastic bag or bucket.

Classification of Samples

Bulk drill cuttings and discrete soil samples were visually-manually classified, based on texture and plasticity, utilizing the procedures outlined in the ASTM D2487-11 standard. The assignment of a group name to each of the collected samples was performed according to the Unified Soil Classification System (ASTM D2488-09). Where reported, plasticity comments on field logs refer to soil behavior at field moisture content unless noted otherwise. Site material classifications are reported on the Field Boring Logs.

FIELD LOG OF BORING B - 1

Sheet 1 of 2

Project: *TENTATIVE TRACT MAP NO. 37154*

Location: *TEMESCAL VALLEY, RIVERSIDE COUNTY, CA.*

Date(s) Drilled:	**4/12/16**	Logged By:	**M. Doerschlag**
Drilled By:	**GP Drilling**	Total Depth:	**26.5 Ft.**
Rig Make/Model:	**Mobile B-61**	Hammer Type:	**Automatic trip**
Drilling Method:	**Hollow-Stem Auger**	Hammer Weight/Drop:	**140 Lb./30 In.**
Hole Diameter:	**8 In.**	Surface Elevation:	**± 1398.5 Ft. AMSL per site plan**

Comments: Located adjacent to proposed Lot 13, native-ground surface west of fault trench FT-3 alignment.

DEPTH (ft.)	ELEVATION (MSL DATUM)	SAMPLE INTERVALS: TYPE, "N" or (Blows/ft.)	USCS	GEOTECHNICAL DESCRIPTION	DRY DENSITY (pcf)	WATER CONTENT (%)	OTHER TESTS
0			SM	Silty Sand: Brown; medium dense; moist (from irrigation); fine to coarse grained sand and up to 20% gravel; massive and featureless (churned). [Younger alluvium, Qyf]			
	1395	RING 8 10 9 (19)	SM	← Silty sand, as above, not visibly porous.	119.3	4.4	
5		RING 6 11 11 (22)		← Silty sand, with few pinhole pores.	116.3	3.1	
		RING 9 14 11 (25)	SM	Silty Sand: Light brown to light yellowish brown; medium dense; slightly moist; fine to coarse grained sand and common 1"-2" weathered granitic gravel; massive; well-packed and not visibly porous textures. Lacks illuvial clay horizons (presumed eroded away). [Older alluvium, Qof]	117.8	2.6	CONSOL
	1390						
10		RING 10 19 14 (33)	SM	← Silty sand, light yellowish brown, low cohesion.	125.6	1.8	CONSOL
	1385						
15							

Continued on following sheet.

FIELD LOG OF BORING B - 1

Project: *TENTATIVE TRACT MAP NO. 37154*

Location: *TEMESCAL VALLEY, RIVERSIDE COUNTY, CA.*

DEPTH (ft.)	ELEVATION (MSL DATUM)	SAMPLE INTERVALS: TYPE, "N" or (Blows/ft.)	GRAPHIC LOG	USCS	GEOTECHNICAL DESCRIPTION	DRY DENSITY (pcf)	WATER CONTENT (%)	WELL COMPLETION	OTHER TESTS
15		RING 15 21 21 (42)		SW-SM	Silty Sand: Light yellowish brown; medium dense; slightly moist. At 15' has lower fines than typical and classifies as well-graded gravelly sand with minor silt, including mixed clasts in low-cohesion matrix. Few FeO grain stains.[Older alluvium, Qof]	120.8	2.4		
	1380								
20		SPT 13 15 16 N=31		SM	← Silty sand, grades brown and with estimated 35-40% silt, sand granules weathered and friable, slightly cemented. May be a paleosol.				
	1375								
25		SPT 21 29 32 N=61		SM	← Gravelly silty sand, very dense, with ~15% fines, highly weathered mixed clasts to 2"+, slightly cemented.				

Bottom of boring at 26.5 ft.
No groundwater encountered.
Boring backfilled with compacted soil cuttings.

FIELD LOG OF BORING B - 2

Sheet 1 of 2

Project: ***TENTATIVE TRACT MAP NO. 37154***

Location: ***TEMESCAL VALLEY, RIVERSIDE COUNTY, CA.***

Date(s) Drilled:	**4/12/16**	Logged By:	**M. Doerschlag**
Drilled By:	**GP Drilling**	Total Depth:	**20.3 Ft.**
Rig Make/Model:	**Mobile B-61**	Hammer Type:	**Automatic trip**
Drilling Method:	**Hollow-Stem Auger**	Hammer Weight/Drop:	**140 Lb./30 In.**
Hole Diameter:	**8 In.**	Surface Elevation:	**± 1414.0 Ft. AMSL per site plan**

Comments: Located within proposed Lot 1, native-ground surface west of fault trench FT-3 alignment.

DEPTH (ft.)	ELEVATION (MSL DATUM)	SAMPLE INTERVALS: TYPE, "N" or (Blows/ft.)	USCS	GEOTECHNICAL DESCRIPTION	DRY DENSITY (pcf)	WATER CONTENT (%)	OTHER TESTS
0			SM	Silty Sand: Dark brown; loose; moist; mostly fine to medium grained sand with scattered angular metamorphic clasts and around 30-35% total fines; massive. Common roots and pores. [Colluvium]			BULK: MAX, EI, SHEAR, SULFATE, CHLORIDE, pH, RESISTIVITY
		RING 2 3 6 (9)	SM	← Silty sand, as above.	100.4	5.3	
	1410						
5		RING 8 9 13 (22)	SM/ML	← Silty sand with at least 40-45% fines including traces of clay, visibly porous.	98.9	6.6	CONSOL
		RING 9 12 13 (25)	SM	← Silty sand, slightly cemented with traces of clay, estimated 15% angular fine-grained gravel, visibly porous.	101.3	8.5	CONSOL
	1405						
10		RING 9 12 15 (27)	SM	← Silty sand, grades brown, slightly cemented and with traces of gravel. Partly derived from granitic source.	93.7	8.4	
			ROCK	Monzodiorite: Variegated strong brown to light brown; medium grained equigranular hypidiomorphic texture; extremely to highly weathered, moist; soft; extremely weak and friable. Easily drilled. [Granitic bedrock]			
	1400						
15							

Continued on following sheet.

FIELD LOG OF BORING B - 2

Project:	***TENTATIVE TRACT MAP NO. 37154***
Location:	***TEMESCAL VALLEY, RIVERSIDE COUNTY, CA.***

DEPTH (ft.)	ELEVATION (MSL DATUM)	SAMPLE INTERVALS: BULK	SAMPLE INTERVALS: DRIVE	TYPE, "N" or (Blows/ft.)	GRAPHIC LOG	USCS	GEOTECHNICAL DESCRIPTION	DRY DENSITY (pcf)	WATER CONTENT (%)	WELL COMPLETION	OTHER TESTS
15				RING *50/4"		ROCK	Monzodiorite: Variegated strong brown to light brown; medium grained equigranular hypidiomorphic texture; extremely to highly weathered, moist; soft; extremely weak and friable, freshening slowly with depth. Easily drilled. [Granitic bedrock]	100.3	7.2		
	1395										
20				SPT *50/3"			← No recovery.				

Bottom of boring at 20.3 ft.
No groundwater encountered.
Boring backfilled with compacted soil cuttings.

FIELD LOG OF BORING B - 3

Project:	*TENTATIVE TRACT MAP NO. 37154*
Location:	*TEMESCAL VALLEY, RIVERSIDE COUNTY, CA.*

Date(s) Drilled:	**4/12/16**	Logged By:	**M. Doerschlag**
Drilled By:	**GP Drilling**	Total Depth:	**24.5 Ft.**
Rig Make/Model:	**Mobile B-61**	Hammer Type:	**Automatic trip**
Drilling Method:	**Hollow-Stem Auger**	Hammer Weight/Drop:	**140 Lb./30 In.**
Hole Diameter:	**8 In.**	Surface Elevation:	**± 1424.0 Ft. AMSL per site plan**

Comments: Located within proposed Lot 9, native-ground surface north of fault trench FT-1 alignment.

DEPTH (ft.)	ELEVATION (MSL DATUM)	SAMPLE INTERVALS: TYPE, "N" or (Blows/ft.)	USCS	GEOTECHNICAL DESCRIPTION	DRY DENSITY (pcf)	WATER CONTENT (%)	OTHER TESTS
0			SM	Silty Sand: Light brown; loose; moist 0-2' but slightly moist below; fine to coarse grained sand with typical 5-15% small gravel; massive; low cohesion. [Younger alluvium, Qyf]			
	1420	RING 6 7 7 (14)	SM	← Silty sand, as above.	115.6	2.6	
5			SP-SM	Sand with Silt: Light brown; medium dense; slightly moist; fine to coarse-grained sand with traces of gravel; stratified (observed in trench exposures); mostly cohesionless. [Younger alluvium, Qyf]			
		RING 7 7 8 (15)	SP-SM	← Sand with silt, as above.	112.7	1.6	
				↙ Becomes increasingly gravelly, hard durable clasts.			
	1415						
10		RING 14 12 12 (24)	SW-SM	← Gravelly sand, layered and locally silty.	118.0	2.1	
			SM	Gravelly Silty Sand: Yellowish brown; medium dense; moist. Seen in trench exposures as a massive mudflow deposit with some large angular granitic cobbles and boulders, rocky drilling. [Younger alluvium, Qyf]			
	1410			Silty Sand: Yellowish brown; dense; slightly moist; fine to coarse sand and some fine to medium immature gravel; well-packed textures; not visibly porous. [Older alluvium, Qof]			
15							

Continued on following sheet.

FIELD LOG OF BORING B - 3

Project: ***TENTATIVE TRACT MAP NO. 37154***

Location: ***TEMESCAL VALLEY, RIVERSIDE COUNTY, CA.***

DEPTH (ft.)	ELEVATION (MSL DATUM)	SAMPLE INTERVALS: BULK	SAMPLE INTERVALS: DRIVE	TYPE, "N" or (Blows/ft.)	GRAPHIC LOG	USCS	GEOTECHNICAL DESCRIPTION	DRY DENSITY (pcf)	WATER CONTENT (%)	WELL COMPLETION	OTHER TESTS
15				SPT 10 19 20 N=39		SM	Silty Sand: Yellowish brown; dense; slightly moist; fine to coarse sand and some fine to medium immature gravel (mixed clast types), well-packed textures, not visibly porous. [Older alluvium, Qof]				
	1405										
20				SPT 14 14 17 N=33		SM	← Silty sand, lower 15% fines and primarily coarse sand, mixed clast types. Abrupt lower contact.				
						ROCK	Metaquartzite: Dark gray; very fine-grained; moderately to slightly weathered; hard; moderately strong to strong; inferred close fractures. Drills firmly, with slight rig chatter. [Triassic-age meta-sediments]				
	1400										

Refusal encountered at 24.5 ft.
No groundwater encountered.
Boring backfilled with compacted soil cuttings.

FIELD LOG OF BORING B - 4

Project: *TENTATIVE TRACT MAP NO. 37154*

Location: *TEMESCAL VALLEY, RIVERSIDE COUNTY, CA.*

Date(s) Drilled:	**4/12/16**	Logged By:	**M. Doerschlag**
Drilled By:	**GP Drilling**	Total Depth:	**61.5 Ft.**
Rig Make/Model:	**Mobile B-61**	Hammer Type:	**Automatic trip**
Drilling Method:	**Hollow-Stem Auger**	Hammer Weight/Drop:	**140 Lb./30 In.**
Hole Diameter:	**8 In.**	Surface Elevation:	**± 1411.0 Ft. AMSL per site plan**

Comments: Located in proposed Lot 6/13 transition slope area, native-ground surface.

DEPTH (ft.)	ELEVATION (MSL DATUM)	SAMPLE INTERVALS: TYPE, "N" or (Blows/ft.)	USCS	GEOTECHNICAL DESCRIPTION	DRY DENSITY (pcf)	WATER CONTENT (%)	OTHER TESTS
0			SM	Silty Sand: Brown; very loose and disturbed; moist. Topsoil zone with scattered cobbles to 8" across. [Younger alluvium, Qyf]			
	1410		SP-SM	Sand with Silt: Light grayish brown; loose to medium dense; moist; stratified fine to coarse grained sand, low estimated fines of under 10%, and with usually low proportions of hard and durable gravel and rarely a small cobble; cohesionless. [Younger alluvium, Qyf]			BULK: MAX, EI, SHEAR, SE, SULFATE, CHLORIDE, pH, RESISTIVITY
		RING 5 6 7 (15)			121.2	3.5	
5		RING 24 24 24 (48)	SP-SM	← Sample pushed on rock. Low fines (<10%).	Dist.	4.0	
	1405	RING 6 7 12 (19)	SP-SM	← Sand with silt, plus occasional cobble-size rock >3" across. Cohesionless.	106.7	3.0	
10	1400	RING 11 13 13 (26)	SW-SM	Sand with silt, fine to coarse grained, becomes more gravelly beyond 10' (chatter), containing hard durable granitic clasts to 2" across or a little more, cohesionless.	110.5	2.7	
			SP-SM	Becomes less rocky, no chatter.			
15							

Continued on following sheet.

FIELD LOG OF BORING B - 4

Project: ***TENTATIVE TRACT MAP NO. 37154***

Location: ***TEMESCAL VALLEY, RIVERSIDE COUNTY, CA.***

DEPTH (ft.)	ELEVATION (MSL DATUM)	SAMPLE INTERVALS TYPE, "N" or (Blows/ft.)	USCS	GEOTECHNICAL DESCRIPTION	DRY DENSITY (pcf)	WATER CONTENT (%)	WELL COMPLETION	OTHER TESTS
15	1395	RING 11 13 16 (29)	SP-SM	Gravelly Sand: Light brown; medium dense; slightly moist; stratified (based on trench exposures), and with up to 20% hard durable mostly granitic clasts to 2"+, cohesionless. [Younger alluvium, Qyf]	110.7	2.1		
20	1390	RING 11 14 14 (28)	SP-SM	← Gravelly sand, as above. Approximate contact.	117.0	2.2		
			SP-SM	Gravelly Sand: Light yellowish brown; dense; slightly moist; fine to coarse-grained immature sands with 15-20% fine angular and usually weathered gravel (mostly granitics but some phyllite and quartzite); well-packed and not visibly porous. No pedogenic horizon. Easy drilling. [Older alluvium, Qof]				
25	1385	RING 12 24 22 (56)	SP-SM	← Gravelly sand, uncemented.	115.5	1.9		
30	1380	SPT 9 13 23 N=36	SM	Silty Sand: Light brown; dense; slightly moist; layered fine to coarse grained sand with variable 15-40% silt proportions and some metamorphic gravel to ~1½" diameter. Lacks FeO mottles. Uncemented. [Older alluvium, Qof]				
35								

Continued on following sheet.

Project: ***TENTATIVE TRACT MAP NO. 37154***

Location: ***TEMESCAL VALLEY, RIVERSIDE COUNTY, CA.***

DEPTH (ft.)	ELEVATION (MSL DATUM)	SAMPLE INTERVALS TYPE, "N" or (Blows/ft.)	GRAPHIC LOG	USCS	GEOTECHNICAL DESCRIPTION	DRY DENSITY (pcf)	WATER CONTENT (%)	WELL COMPLETION	OTHER TESTS
35	1375	SPT 11 18 18 N=36		SM	Silty Sand: Light brown; dense; slightly moist; faintly layered fine to coarse grained sand, and less silty than above and only traces of gravel. Uncemented. [Older alluvium, Qof]				
				SW-SM	Gravelly Sand: Light olive brown; very dense; slightly moist. Estimated 10% fines, 30% weathered gravel (mixed clast origins), in well-packed sediments exhibiting a few fine grain stains and oxidation spots. [Older alluvium, Qof]				
40	1370	SPT 45 37 35 N=72		SW-SM	← Gravelly sand, as above.				
45	1365	SPT 26 26 38 N=64		SW-SM	Gravelly sand, weathered grantiic clasts to >3" diameter. well-packed and massive to faintly layered.				
					↙ Becomes rockier, with persistent light rig chatter but not hard drilling. Clasts consist of harder 1"-3" metamorphic types.				
50	1360	SPT *50/6"		SW-SM	← Gravelly sand.				
					↙ No chatter, less rocky.				
55									

Continued on following sheet.

FIELD LOG OF BORING B - 4

Project: ***TENTATIVE TRACT MAP NO. 37154***

Location: ***TEMESCAL VALLEY, RIVERSIDE COUNTY, CA.***

DEPTH (ft.)	ELEVATION (MSL DATUM)	SAMPLE INTERVALS: TYPE, "N" or (Blows/ft.)	GRAPHIC LOG	USCS	GEOTECHNICAL DESCRIPTION	DRY DENSITY (pcf)	WATER CONTENT (%)	WELL COMPLETION	OTHER TESTS
55	1355	SPT 15 29 29 N=58		SP-SM	Gravelly Sand: At 55 feet, generally light brown; very dense; slightly moist. Sample cored through a weathered granite cobble or boulder >6" across. Matrix layered 2"-4" thick. May grade to sandy gravel & cobbles, with notable bounce and chatter from 57-58 feet. [Older alluvium, Qof]				
60	1350	SPT 16 19 27 N=46		SM	← Silty sand with some Jbc gravel to ~1", dense, crudely bedded.				

Bottom of boring at 61.5 ft.
No groundwater encountered.
Boring backfilled with compacted soil cuttings.

FIELD LOG OF BORING B - 5

Sheet 1 of 2

Project:	*TENTATIVE TRACT MAP NO. 37154*
Location:	*TEMESCAL VALLEY, RIVERSIDE COUNTY, CA.*

Date(s) Drilled:	**4/12/16**	Logged By:	**M. Doerschlag**
Drilled By:	**GP Drilling**	Total Depth:	**26.5 Ft.**
Rig Make/Model:	**Mobile B-61**	Hammer Type:	**Automatic trip**
Drilling Method:	**Hollow-Stem Auger**	Hammer Weight/Drop:	**140 Lb./30 In.**
Hole Diameter:	**8 In.**	Surface Elevation:	**± 1411.0 Ft. AMSL per site plan**

Comments: Located adjacent to proposed Lot 5, in adjacent TTM 37027 remainder lot. Borehole is in shallow cut.

DEPTH (ft.)	ELEVATION (MSL DATUM)	SAMPLE INTERVALS: BULK / DRIVE	TYPE, "N" or (Blows/ft.)	GRAPHIC LOG	USCS	GEOTECHNICAL DESCRIPTION	DRY DENSITY (pcf)	WATER CONTENT (%)	WELL COMPLETION	OTHER TESTS
0	1410				SW-SM	Gravelly Sand: Light grayish brown; medium dense; dry; fine to coarse grained sand and up to 35% gravel; some small cobbles (rocky) from 0-3' depth; cohesionless. [Younger alluvium, Qyf]				
		DRIVE	RING 7 13 13 (26)		SW-SM	← Gravelly sand, as above.	118.1	1.4		
5	1405	DRIVE	RING 13 12 9 (21)		SP-SM	← Gravelly sand with lower gravel %.	Dist.	Dist.		
		DRIVE	RING 13 13 12 (25)		SM	Gravelly Silty Sand: Light brown to light yellowish brown; medium dense; slightly moist becoming dry; fine to coarse grained sand with typical estimated 20-25% proportions of variably weathered gravel; slightly cemented; well-packed and not visibly porous textures. [Older alluvium, Qof]	106.1	3.8		
10	1400	DRIVE	RING 11 11 16 (27)		SM	← Gravelly silty sand, with weathered granite clasts to >3" across.	Dist.	1.6		
15										

Continued on following sheet.

FIELD LOG OF BORING B - 5

Project: **_TENTATIVE TRACT MAP NO. 37154_**

Location: **_TEMESCAL VALLEY, RIVERSIDE COUNTY, CA._**

DEPTH (ft.)	ELEVATION (MSL DATUM)	SAMPLE INTERVALS: TYPE, "N" or (Blows/ft.)	USCS	GEOTECHNICAL DESCRIPTION	DRY DENSITY (pcf)	WATER CONTENT (%)	WELL COMPLETION	OTHER TESTS
15	1395	RING 16 13 13 (26)	SM	Gravelly Sand: Near 15' becomes light yellowish brown and low fines; medium dense; dry; fine to coarse grained sand and at least 25% weathered granitic gravel to 2"+ diameter, cohesionless. [Older alluvium, Qof]	115.3	1.4		
20	1390	SPT 28 37 28 N=65	SM	← Gravelly sand, as above but very dense and now faintly layered 1"-3" thick, some stones to >2" across inlcuding hard quartzite.				
25	1385	SPT 8 12 13 N=25	SM	← Classifies silty sand, with ~20% fines, massive, weak cohesion, not visibly porous.				

Bottom of boring at 26.5 ft.
No groundwater encountered.
Boring backfilled with compacted soil cuttings.

APPENDIX B

A P P E N D I X B

LABORATORY TESTING & SLOPE STABILITY MODELS

Water Content - Dry Density Determinations – ASTM D2216-10

The dry unit weight and field moisture content were determined for each of the recovered barrel samples. The moisture-density information provides a gross indication of soil consistency and can assist in delineating local variations. The information can also be used to correlate soils and define units between individual exploration locations on the project site, as well as with units found on other sites in the general area.

Measured dry densities ranged from approximately 93.7 to 125.6 pounds per cubic foot. Water contents in ring samples ranged from 1.4 to 8.5 percent of dry unit weight. Sample locations and the corresponding test results are illustrated on the Field Boring Logs.

Modified Effort Compaction Tests – ASTM D1557-12

Two bulk soil samples considered representative of future fill materials were tested to determine their maximum dry densities and optimum water contents per the Method A procedure in the noted ASTM standard. The test method uses 25 blows of a 10-pound hammer falling 18 inches on each of 5 soil layers in a 1/30 cubic foot cylinder. Soil samples were prepared at varying moisture contents to create a curve illustrating achieved dry density as a function of water content. The test results are listed below and shown graphically on pages B-4 and B-5.

Soil Description	Location	Maximum Dry Density (pcf)	Optimum Water Content (%)
Dark Brown Silty Sand (SM) [Colluvium]	B - 2 @ 0 - 6 ft.	129.0	9.0
Light Brown Gravelly Sand (SP-SM) [Younger fan alluvium]	B - 4 @ 0 - 6 ft.	129.5	7.0

Shear Strength Tests – ASTM D3080-11

Direct shear tests were performed on remolded samples prepared to represent future engineered compacted fill derived from on-site silty colluvium, or more-granular alluvial soil sources. We expect mass grading operations will produce soil masses with equivalent or higher strengths. "Fill" test samples were remolded to approximately 90 percent of the maximum dry density, at optimum water content as determined from a compaction test. All samples were initially saturated, consolidated and drained of excess moisture, and *tested in a direct shear machine of the strain control type. Test samples are initially prepared and/or retained within standard one-inch-high brass rings. Samples were tested at increasing normal loads to determine the Mohr-Coulomb shear strength parameters illustrated on pages B-6 and B-7. Peak and ultimate shear strength values are illustrated on the plots.*

Expansion Index Tests – ASTM D4829-11
A laboratory clay expansion test of typical sandy materials expected to be incorporated into structural compacted fill was performed in general accordance with the 1994 Uniform Building Code Standard 18-2 and subsequent ASTM adoption. A remolded sample is compacted in two layers in a 4-inch I.D. mold to a total compacted thickness of about 1.0 inch, using a 5.5-pound hammer falling 12 inches at 15 blows per layer. The sample is initially at a saturation between 49 and 51 percent. After remolding, the sample is confined under a normal load of 144 pounds per square foot and allowed to soak for 24 hours. The resulting volume change due to increase in moisture content within the sample is recorded and the Expansion Index (EI) calculated.

Soil Description	Location	Expansion Index	Expansion Classification
Dark Brown Silty Sand (SM) [Colluvium]	B - 2 @ 0 - 6 ft.	6	Very Low
Light Brown Gravelly Sand (SP-SM) [Younger fan alluvium]	B - 4 @ 0 - 6 ft.	0	Very low

Sand Equivalent Test – ASTM D2419-09
A sample of near-surface younger fan alluvium was evaluated for relative measures of silt and clay content. Most younger alluvium would actually have a slightly lower fines proportion than the tested sample. The suitability of materials for use as select bedding material around wet or dry utilities is commonly based on meeting a minimum sand equivalent value. Three trials were run with soil samples placed in graduated cylinders with a volume of flocculating solution. Agitation and irrigation through a siphon device force the soil fines into suspension. After a prescribed sedimentation period, the heights of flocculated fines and sand are determined. The following table summarizes results.

Soil Description	Location	Sand Equivalent
Light Brown Gravelly Sand (SP-SM) [Younger fan alluvium]	B - 4 @ 0 - 6 ft.	62

Consolidation Tests – ASTM D2435M-11

In this procedure, a series of cumulative vertical loads are applied to a small, laterally confined soil sample. The apparatus is designed to accept a one-inch-high brass ring containing an undisturbed or remolded soil sample. During each load increment, vertical compression (consolidation) of the sample is measured and recorded at selected time intervals. Porous stones are placed in contact with both sides of the specimen to permit the ready addition or release of water. Undisturbed samples are initially at field moisture content, and are subsequently inundated to determine soil behavior under saturated conditions. The test results are plotted graphically on pages B-8 through B-11.

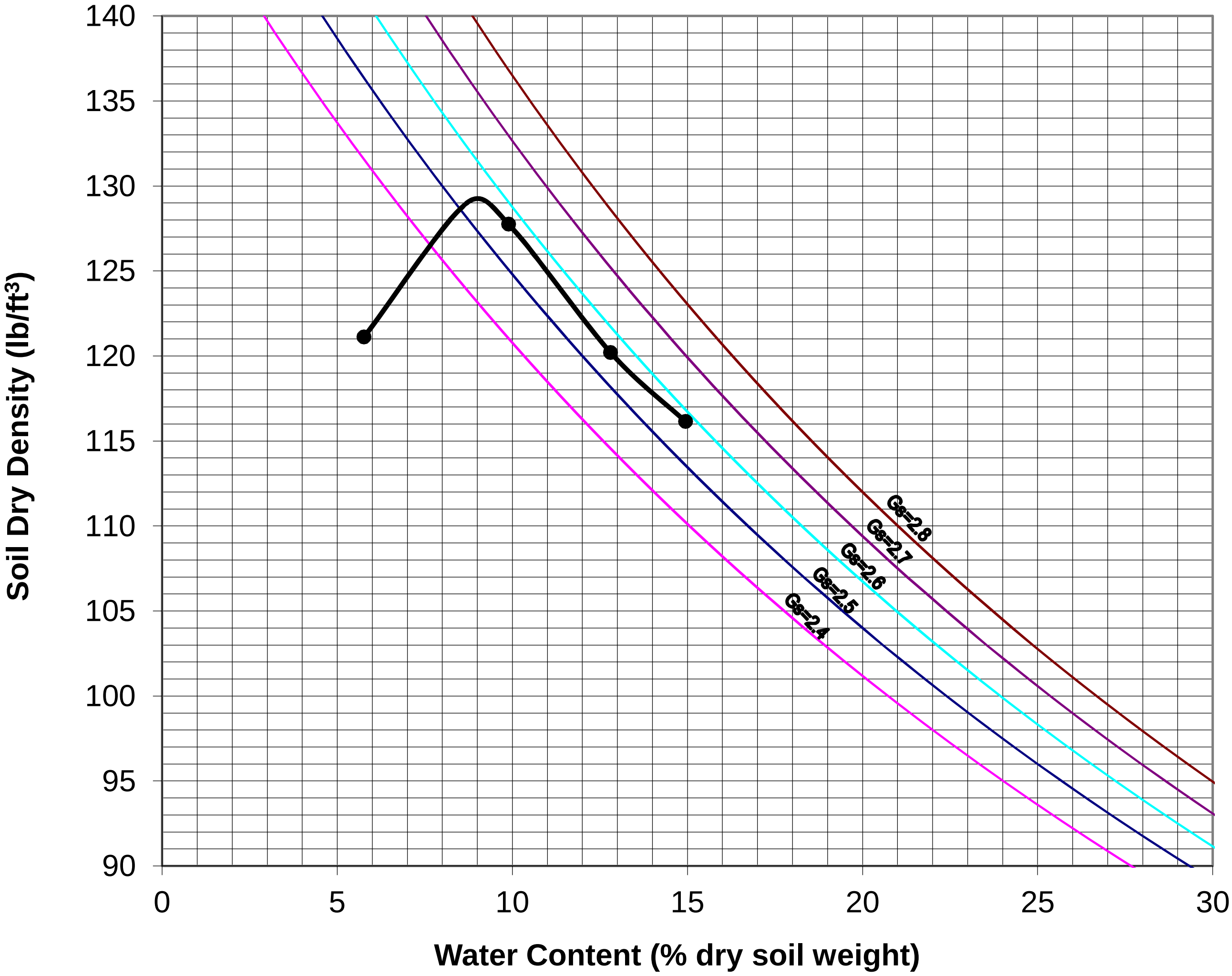
Soil Corrosivity

Colluvial soils were collected from a slope toe area close to future Lot 1, while natural and presumed unaltered alluvium was obtained from a site farther west. Future mass-graded fill created from these soils will be in contact with structural concrete or ferrous metals. Samples were submitted to the laboratories of E.S. Babcock and Sons, Riverside, California, to determine the following tabulated data. Soil pastes were tested per Method S 1.10 for pH and Standard Method 2525B for minimum saturated resistivity. Water-extractible sulfate and chloride contents were determined by ion chromatography.

Soil Description	Location	pH	Minimum Resistivity (ohm-cm)	Water-Soluble Sulfate (wt. %)	Water-Soluble Chloride (ppm)
Silty Sand (SM) [Colluvium]	Boring B - 2, 0 - 6 ft.	6.4	4,400	0.0021	11
Gravelly Sad (SP-SM) [Younger alluvium]	Boring B - 4, 0 - 6 ft.	7.3	12,000	0.0023	ND*

* ND = Non-detectible at the reportable detection limit of 10 ppm or 0.0010%

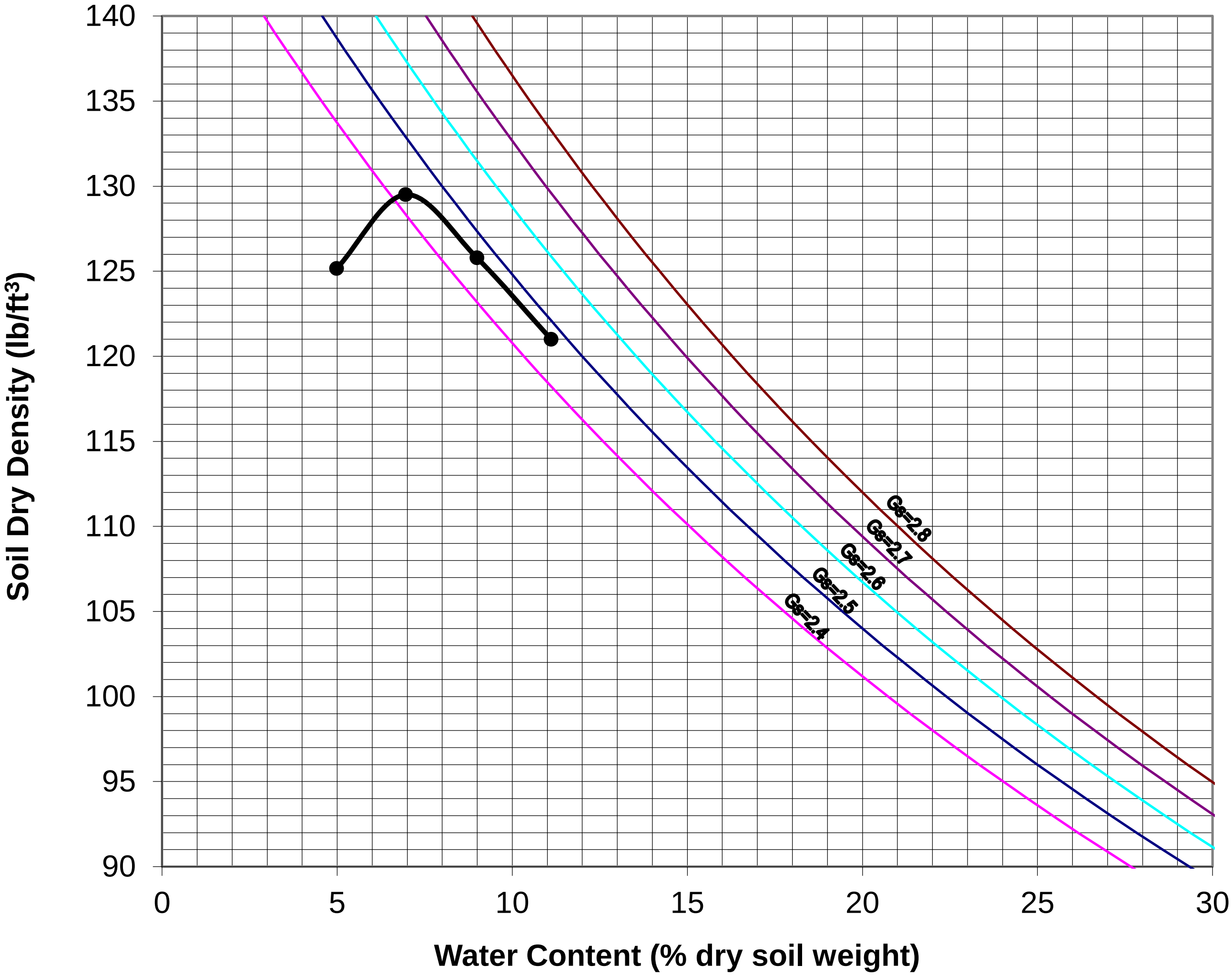
Soil Dry Density vs. Water Content



Boring: B - 2	Depth (ft.): 0.0 - 6.0
Optimum Water Content (%): 9.0	Maximum Density (pcf): 129.0
Sample Description: Silty sand (SM), with traces of gravel and clay. [Colluvium]	

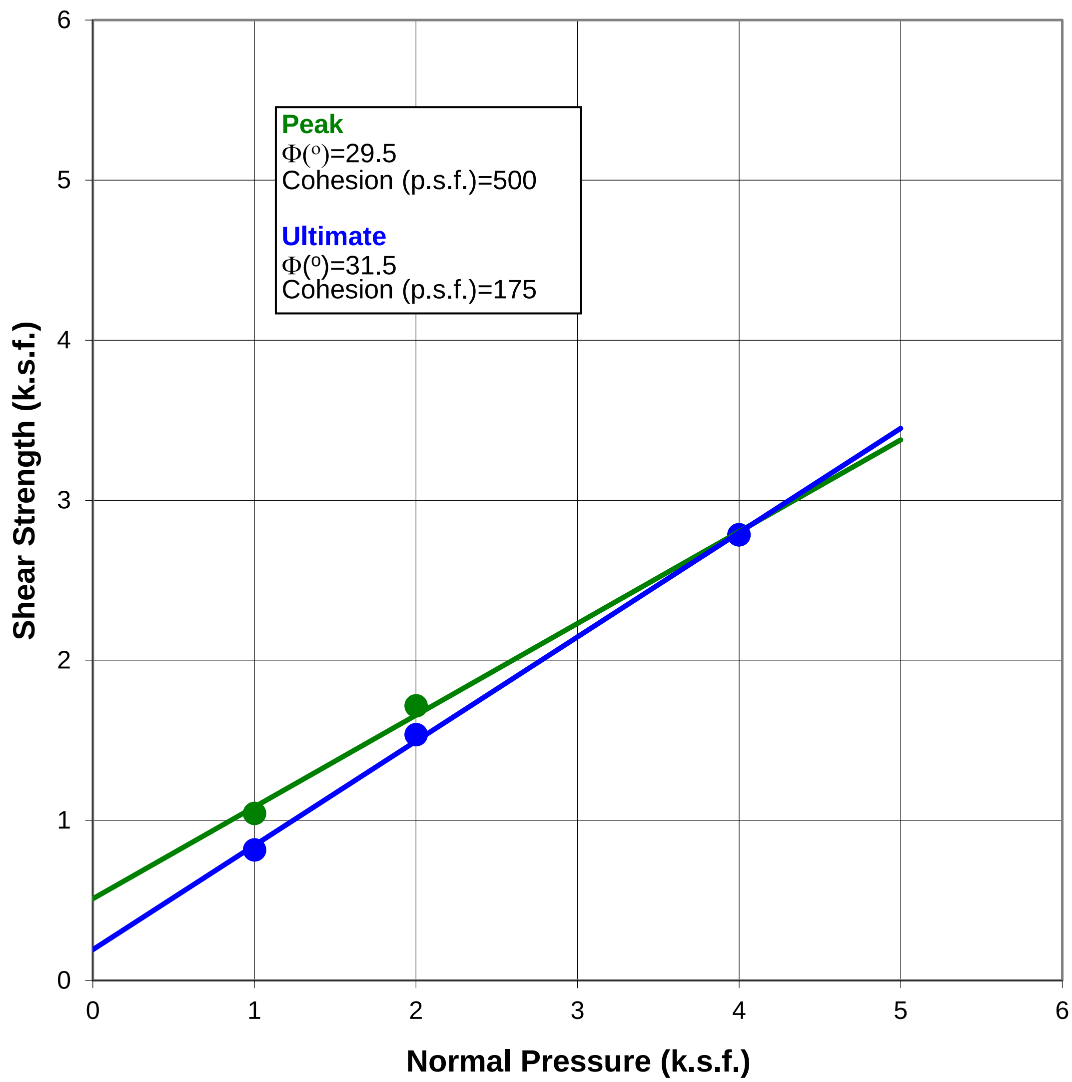
MODIFIED EFFORT COMPACTION CURVE		
TENTATIVE TRACT MAP NO. 37154, TEMESCAL VALLEY, CALIFORNIA		
PROJECT NO. 4252-SF	DATE: 1/30/17	**PAGE B-4**

Soil Dry Density vs. Water Content



Boring: B - 4	Depth (ft.): 0.0 - 6.0	
Optimum Water Content (%): 7.0		Maximum Density (pcf): 129.5
Sample Description: Gravelly sand with silt (SP-SM). [Younger fan alluvium]		

MODIFIED EFFORT COMPACTION CURVE		
TENTATIVE TRACT MAP NO. 37154, TEMESCAL VALLEY, CALIFORNIA		
PROJECT NO. 4252-SF	DATE: 1/30/17	**PAGE B-5**



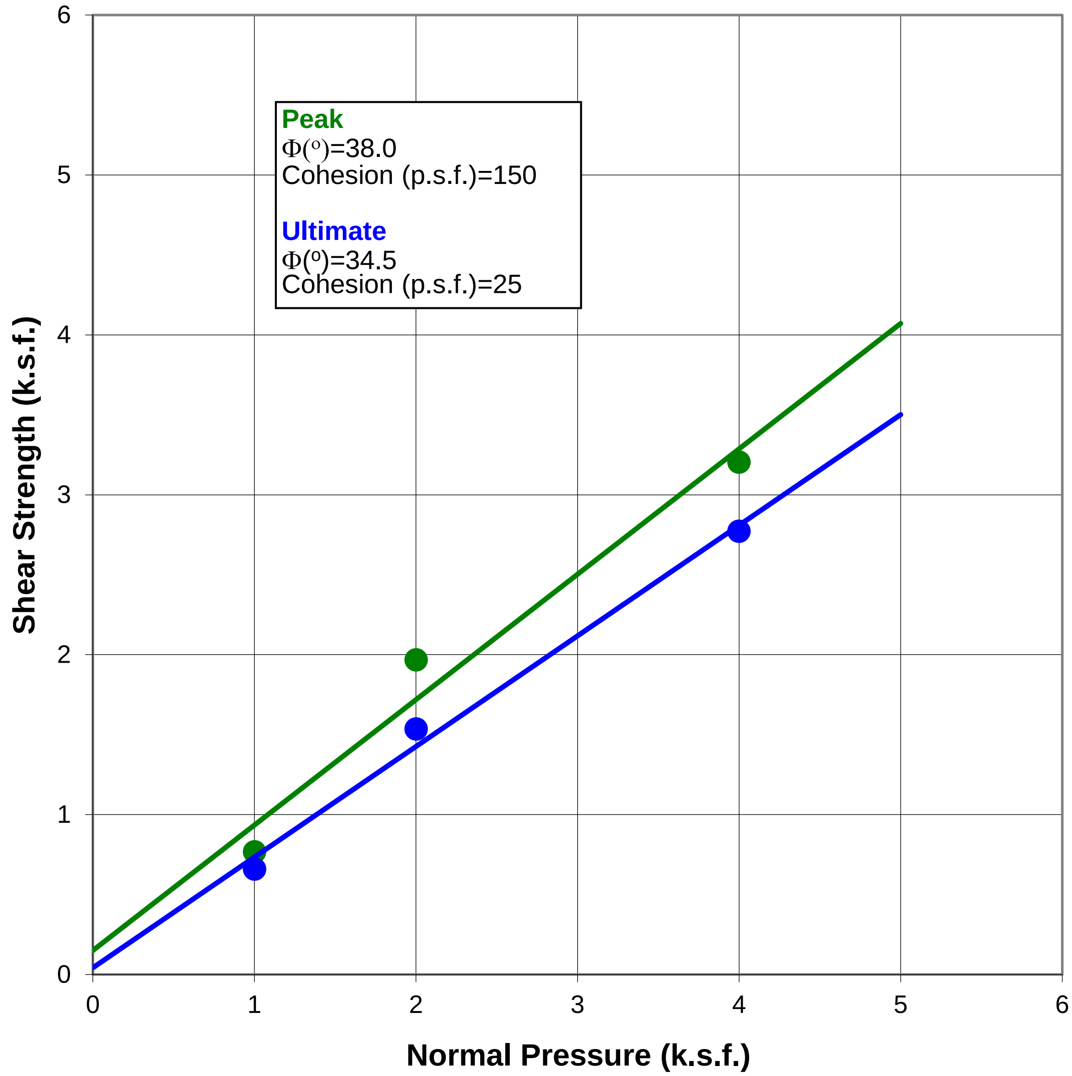
Location: B - 2	Depth (ft.): 0.0 - 6.0	Sample I.D. Number: 16-1176
Test Condition: Remolded, Consolidated, Drained.		
Sample Description: Silty sand (SM), with traces of gravel and clay. [Colluvium]		

AGI

DIRECT SHEAR TEST DIAGRAM

TENTATIVE TRACT MAP NO. 37154, TEMESCAL VALLEY, CALIFORNIA

PROJECT NO. 4252-SF	DATE: 1/30/17	**PAGE B-6**



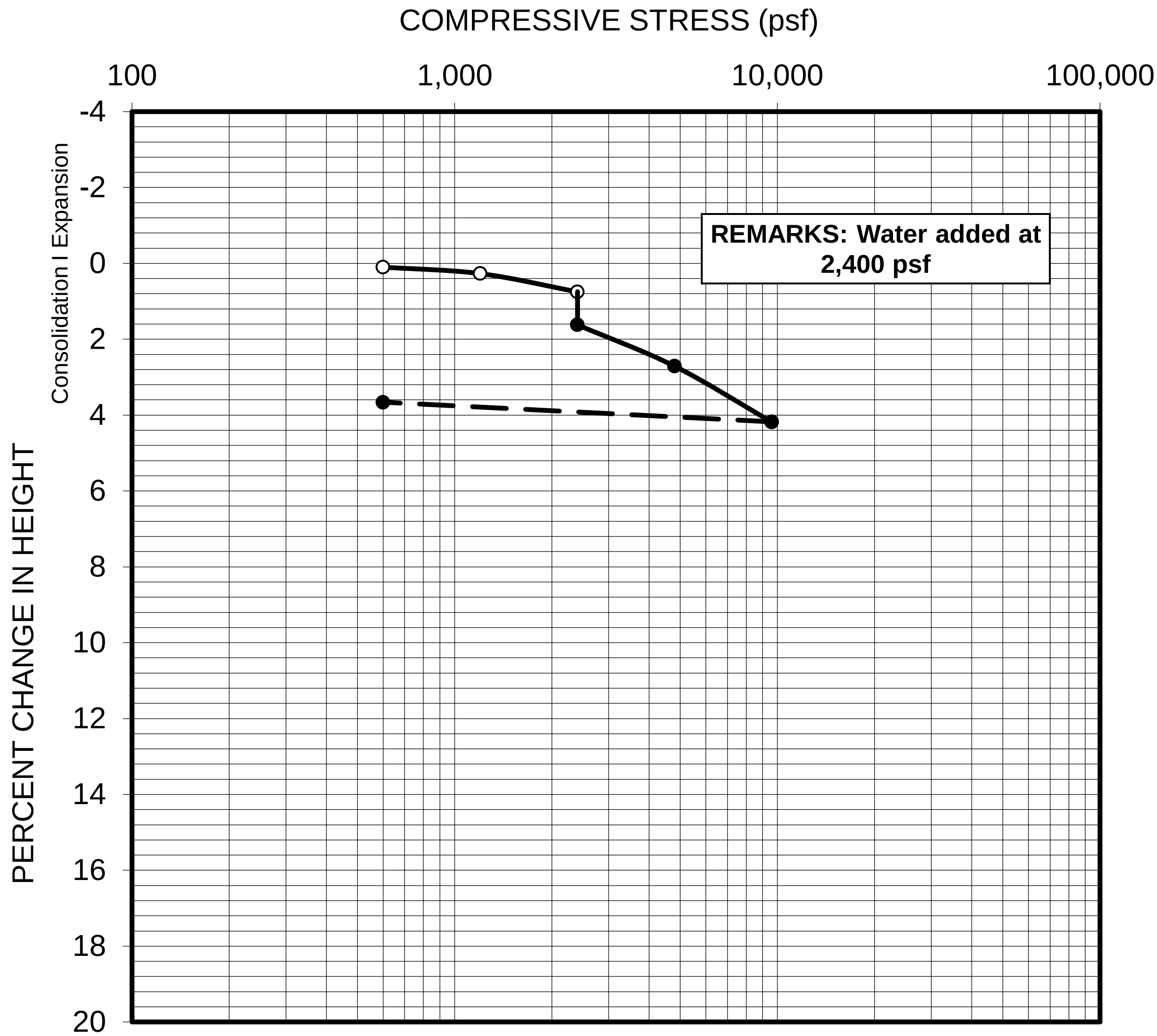
Location: B - 4	Depth (ft.): 0.0 - 6.0	Sample I.D. Number: 16-1173
Test Condition: Remolded, Consolidated, Drained.		
Sample Description: Gravelly sand with silt (SP-SM). [Younger fan alluvium]		

AGI

DIRECT SHEAR TEST DIAGRAM

TENTATIVE TRACT MAP NO. 37154, TEMESCAL VALLEY, CALIFORNIA

PROJECT NO. 4252-SF	DATE: 1/30/17	**PAGE B-7**



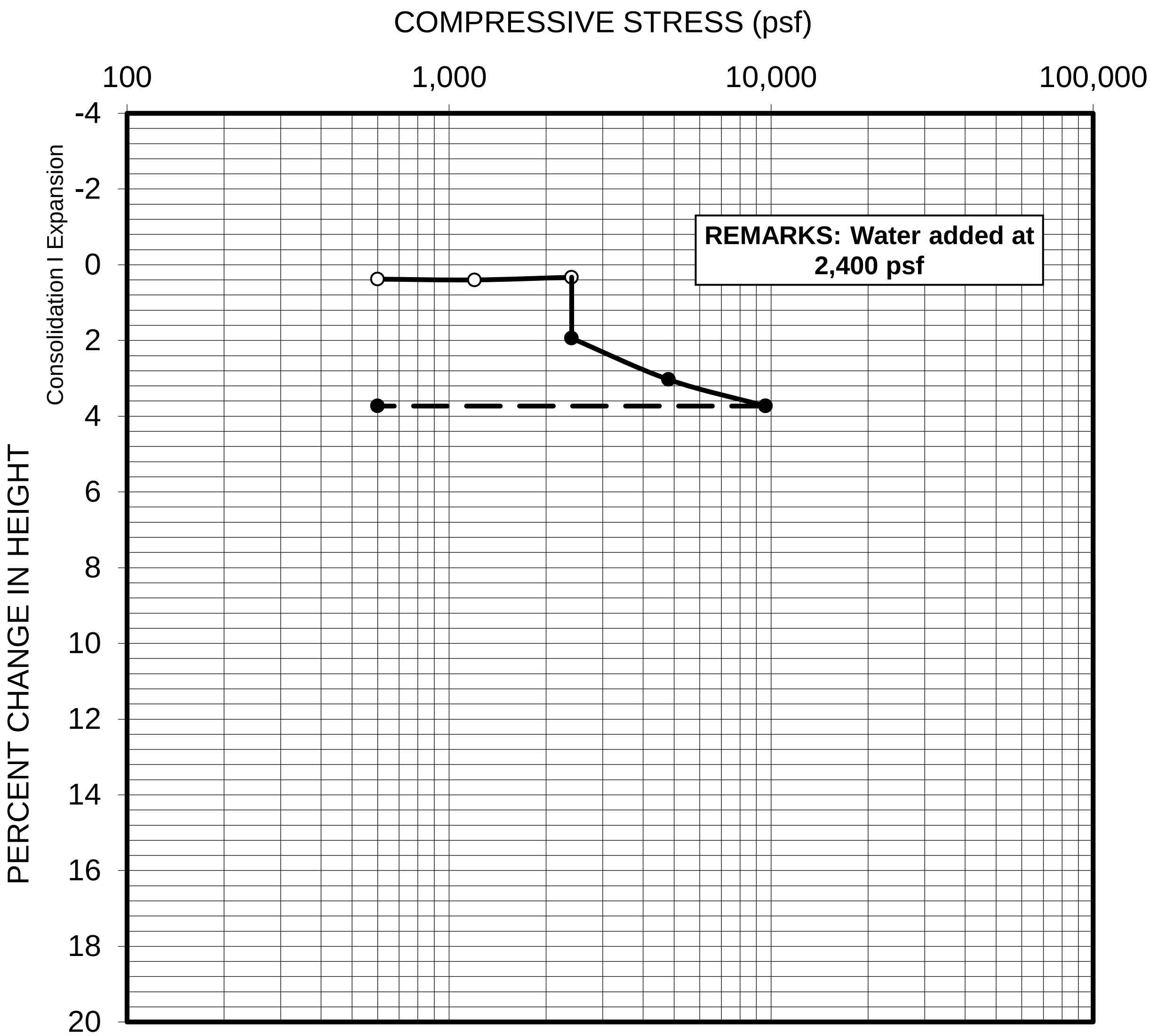
Boring: B - 1	Depth (ft.): 6.0	
Dry Density (pcf): 117.8	Saturation (%): 16.3	Moisture (%): 2.6
Sample Description: Silty sand (SM), fine to coarse grained, not visibly porous. [Older fan alluvium]		

AGI

CONSOLIDATION CURVE

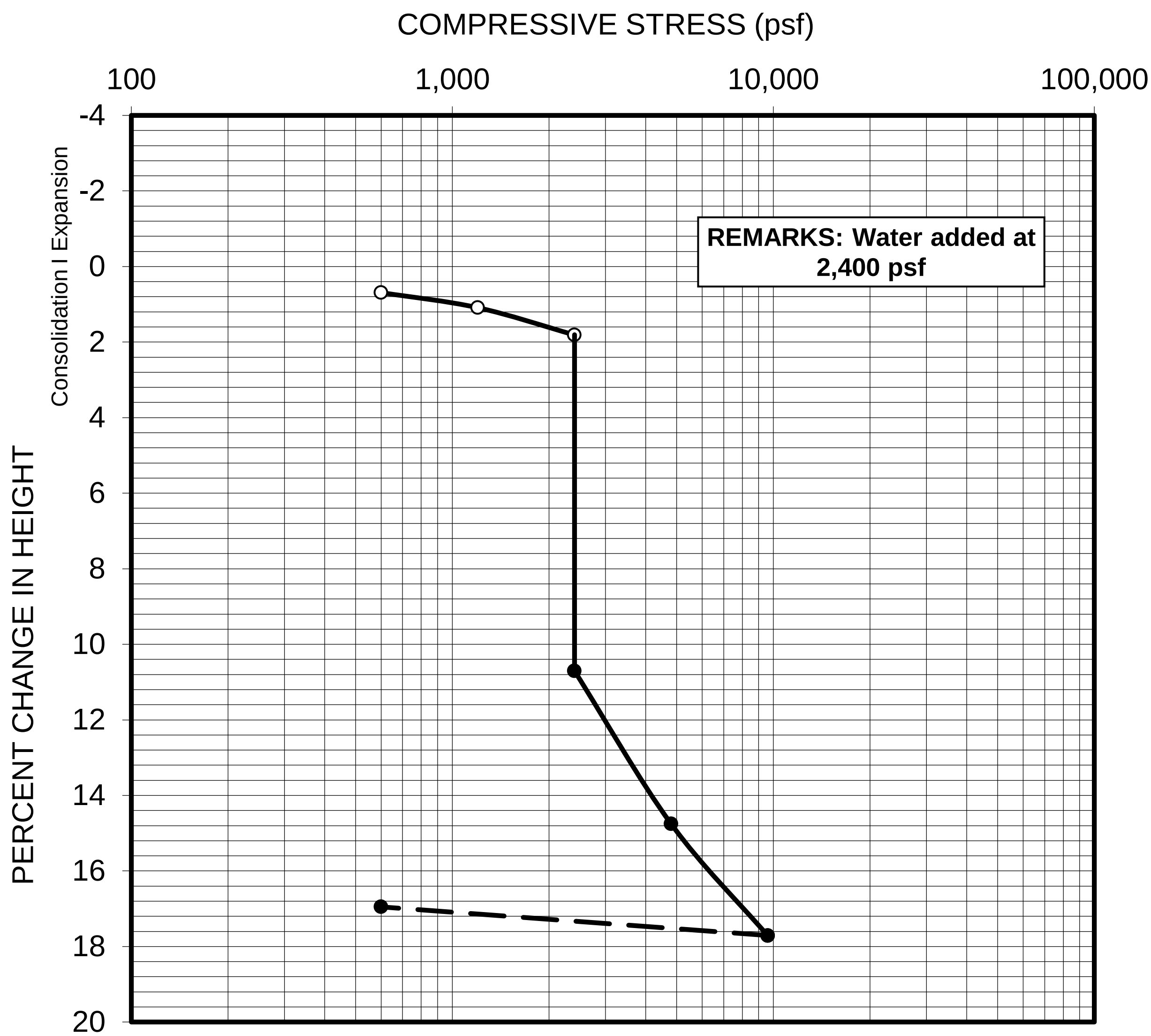
TENTATIVE TRACT MAP NO. 37154, TEMESCAL VALLEY, CALIFORNIA

PROJECT NO. 4252-SF | DATE: 1/30/17 | **PAGE B-8**



Boring: B - 1	Depth (ft.): 10.0	
Dry Density (pcf): 125.6	Saturation (%): 14.2	Moisture (%): 1.8
Sample Description: Silty sand (SM), fine to coarse grained, not visibly porous. [Older fan alluvium]		

CONSOLIDATION CURVE		
TENTATIVE TRACT MAP NO. 37154, TEMESCAL VALLEY, CALIFORNIA		
PROJECT NO. 4252-SF	DATE: 1/30/17	**PAGE B-9**

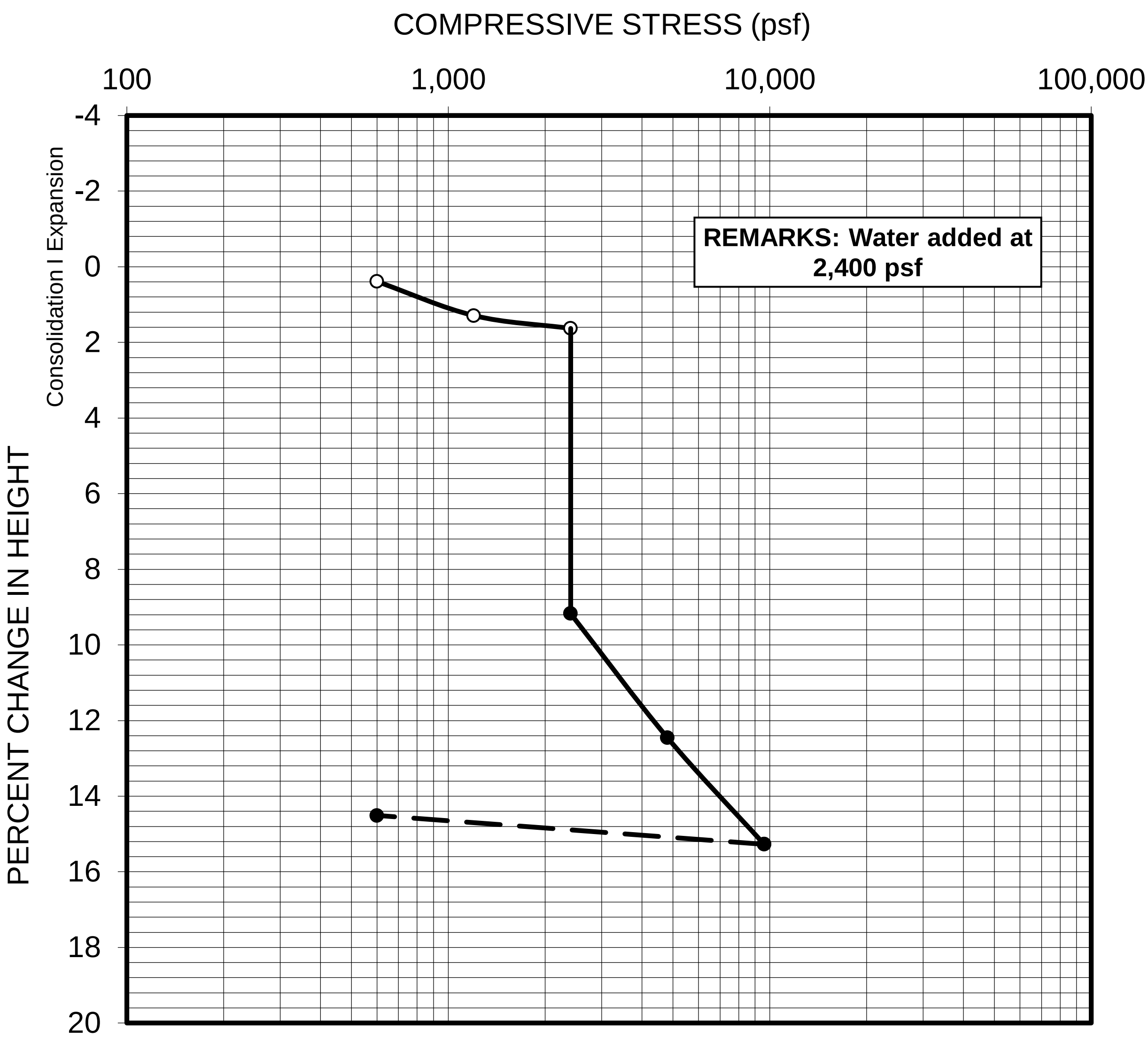


Boring: B - 2	Depth (ft.): 4.0	
Dry Density (pcf): 98.9	Saturation (%): 25.3	Moisture (%): 6.6
Sample Description: Very silty sand (SM/ML), trace clay, visibly porous. [Colluvium]		

CONSOLIDATION CURVE

TENTATIVE TRACT MAP NO. 37154, TEMESCAL VALLEY, CALIFORNIA

PROJECT NO. 4252-SF	DATE: 1/30/17	**PAGE B-10**



Boring: B - 2		Depth (ft.): 6.0	
Dry Density (pcf): 101.3	Saturation (%): 34.6		Moisture (%): 8.5
Sample Description: Silty sand (SM) with some fine gravel, visibly porous. [Colluvium]			

AGI

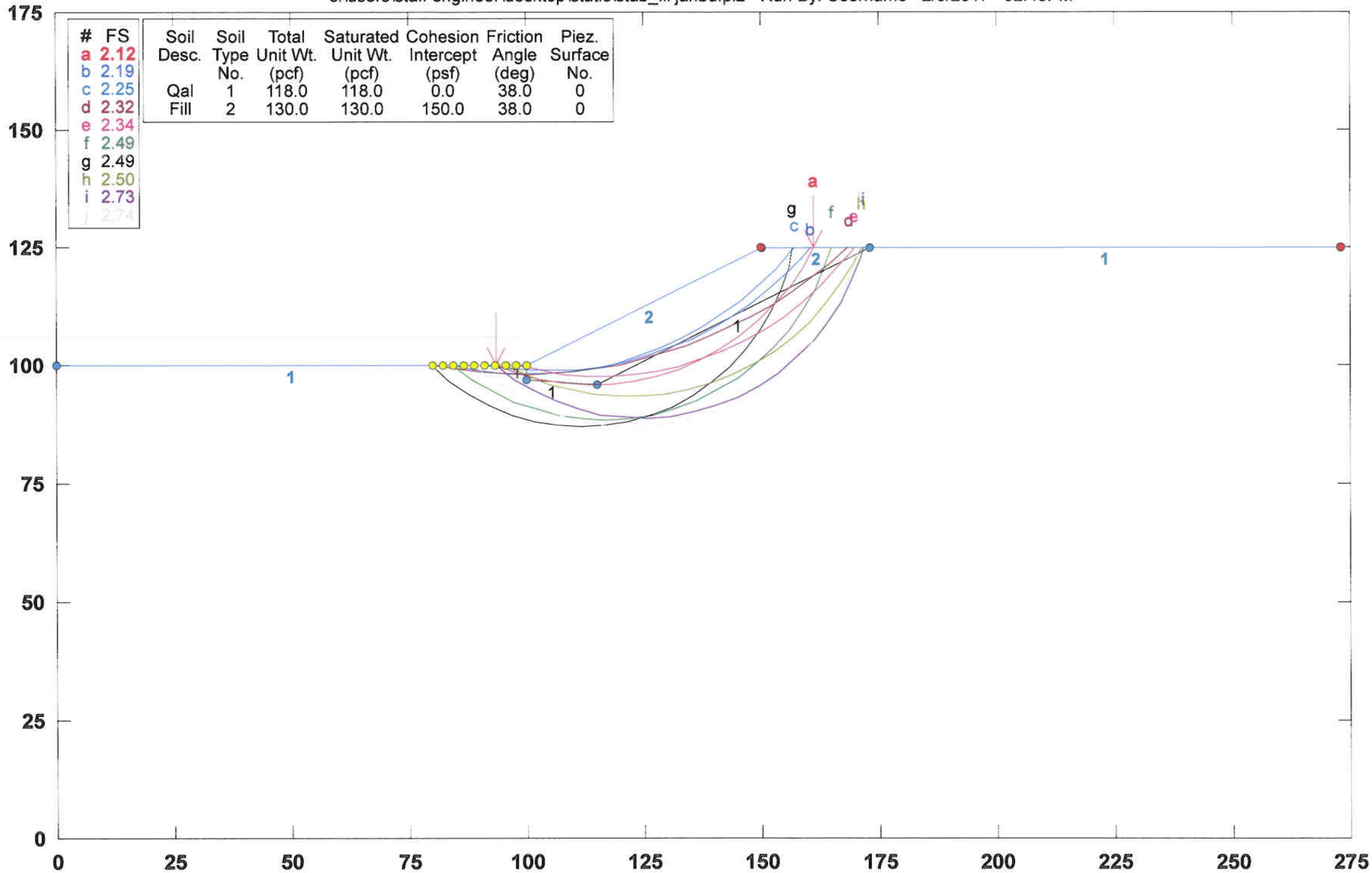
CONSOLIDATION CURVE

TENTATIVE TRACT MAP NO. 37154, TEMESCAL VALLEY, CALIFORNIA

PROJECT NO. 4252-SF	DATE: 1/30/17	**PAGE B-11**

Kiley 35 Slope Stability 4252-SF

c:\users\staff engineer\desktop\static\stab_fil janbu.pl2 Run By: Username 2/6/2017 02:48PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Qal	1	118.0	118.0	0.0	38.0	0
Fill	2	130.0	130.0	150.0	38.0	0

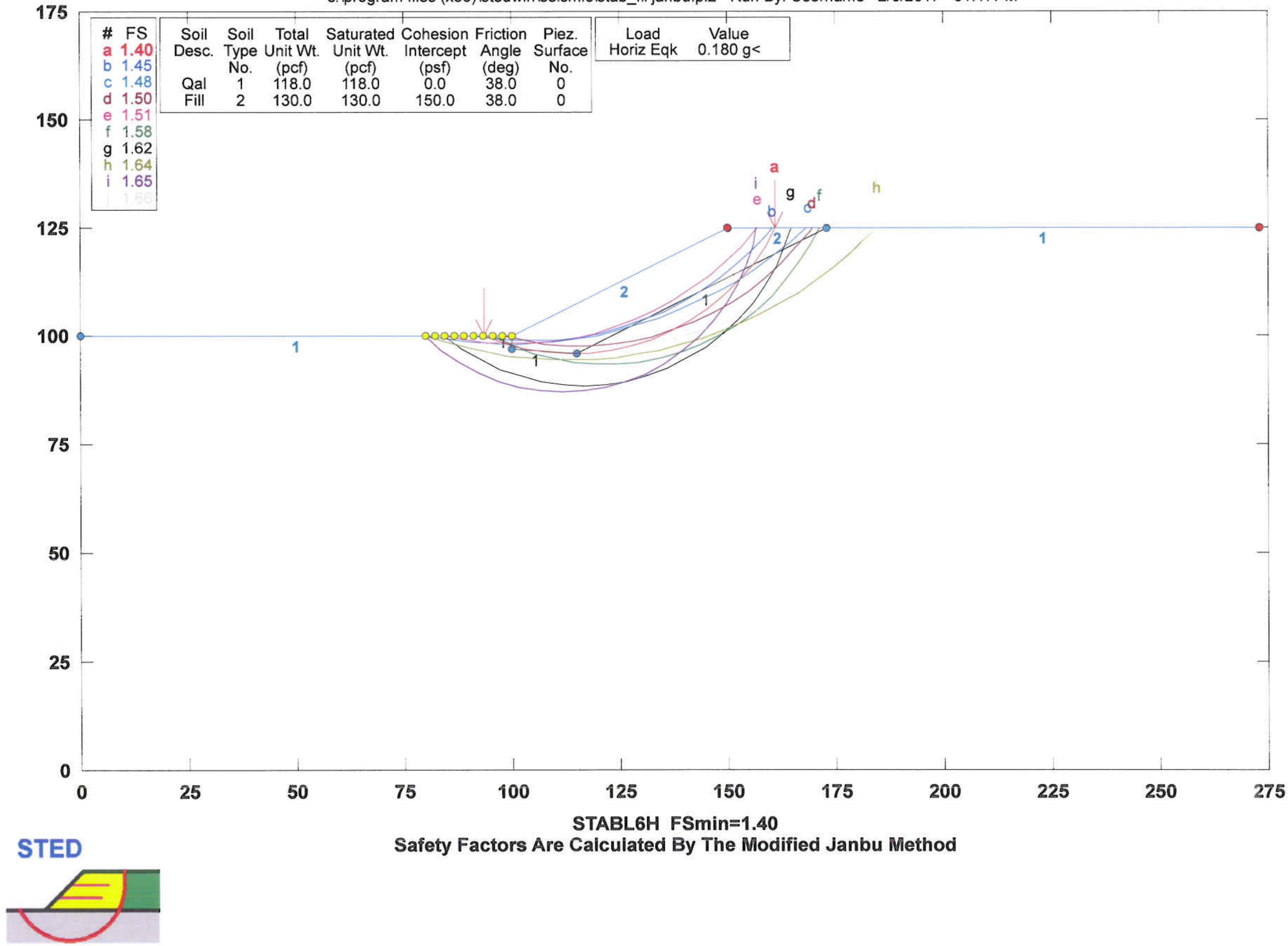
STABL6H FSmin=2.12

Safety Factors Are Calculated By The Modified Janbu Method

STED

Kiley 35 Slope Stability 4252-SF

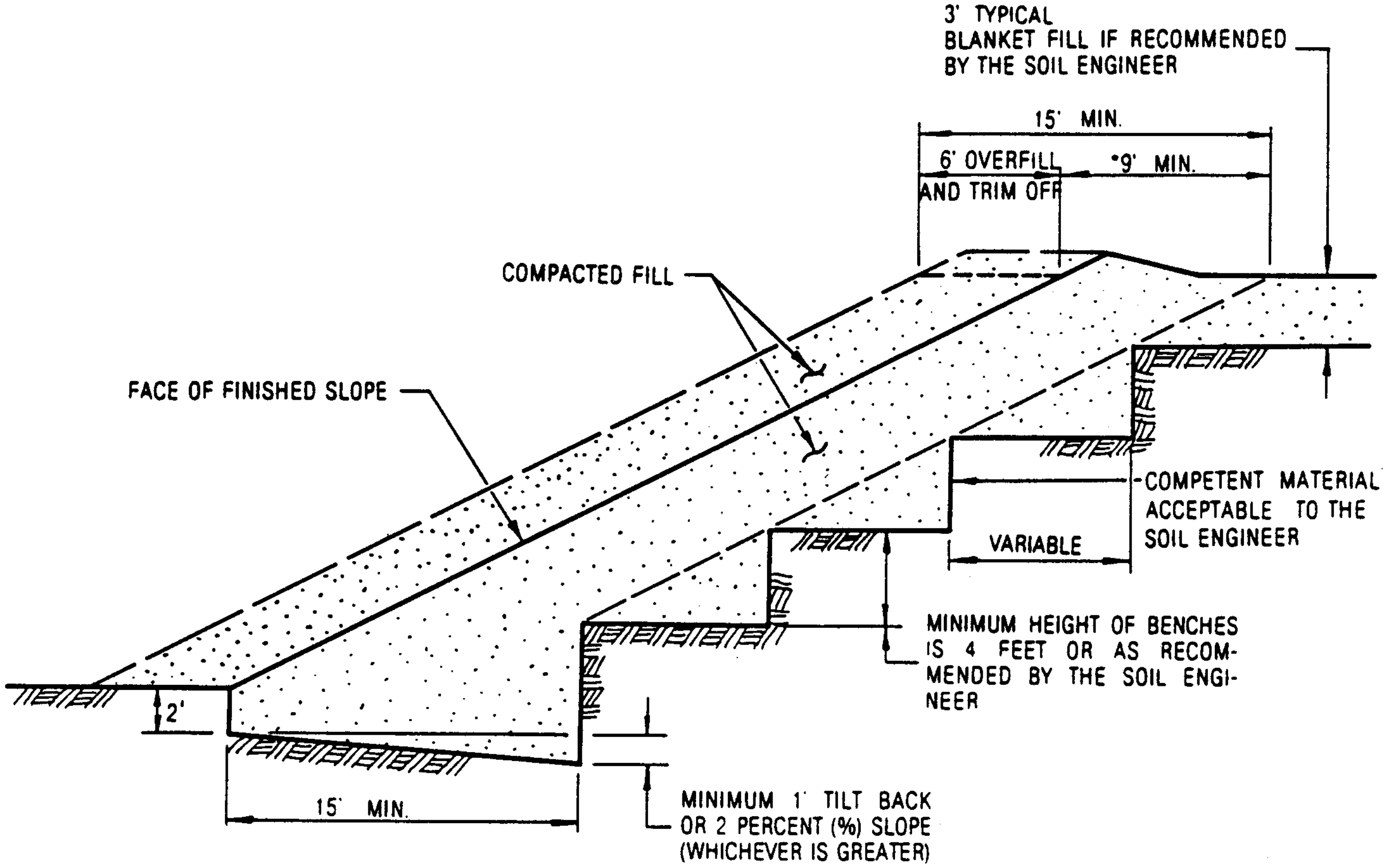
c:\program files (x86)\stedwin\seismic\stab_fil janbu.pl2 Run By: Username 2/6/2017 01:17PM



STABL6H FSmin=1.40

Safety Factors Are Calculated By The Modified Janbu Method

TYPICAL STABILIZATION FILL



NOTE:
SEE PLATE 6 FOR TYPICAL SUBDRAIN DETAILS FOR STABILIZATION FILLS, IF RECOMMENDED BY THE SOIL ENGINEER.

*GREATER THAN 9' IF RECOMMENDED BY THE SOIL ENGINEER: 15' WHERE NO 6' OVERFILL

IN THE COUNTY OF RIVERSIDE, STATE OF CALIFORNIA

TENTATIVE TRACT MAP NO. 37154

LEGAL DESCRIPTION

PARCEL 1

THAT PORTION OF THE WESTERLY RECTANGULAR 1752 OF THE NORTHWEST QUARTER OF SECTION 13, TOWNSHIP 5 SOUTH, RANGE 6 WEST, SAN BERNARDINO BASE AND MERIDIANS, AS SHOWN BY UNITED STATED GOVERNMENT SURVEY, DESCRIBED AS FOLLOWS:

BEGINNING AT A POINT ON THE NORTHERLY LINE OF THE SAID NORTHWEST QUARTER, DISTANT EASTERLY 1725.25 FEET FROM THE NORTHWEST CORNER THEREOF; THENCE SOUTHERLY PARALLEL WITH THE WESTERLY LINE OF THE SAID NORTHWEST QUARTER, 1656 FEET; THENCE WESTERLY PARALLEL WITH THE NORTHERLY LINE OF THE SAID NORTHWEST QUARTER, 430.5 FEET, MORE OR LESS, TO A POINT ON THE EASTERLY LINE OF THAT CERTAIN PARCEL OF LAND CONVEYED TO PAUL D BURNETT AND WIFE BY DEED RECORDED JUNE 3, 1957, AS INSTRUMENT NO. 40469; THENCE SOUTHEASTERLY ON THE EASTERLY LINE OF THE SAID BURNETT PARCEL, 25.5 FEET, TO THE SOUTHEASTERLY CORNER OF THE SAID BURNETT PARCEL; THENCE SOUTH 87° WEST ALONG THE SOUTHERLY LINE OF THE SAID BURNETT PARCEL, AND THE WESTERLY EXTENSION OF SAID BURNETT PARCEL 549 FEET, MORE OR LESS TO A POINT ON THE EASTERLY LINE OF THAT CERTAIN PARCEL CONVEYED TO FALCONER E CAMPBELL JR, BY DEED RECORDED JUNE18, 1957, AS INSTRUMENT NO. 44612, WHICH LIES 760 FEET EAST OF THE WEST LINE OF SECTION 13, AND NORTH 204.2 FEET MORE OR LESS FROM THE SOUTHEAST CORNER OF THE PARCEL CONVEYED TO FALCONER E CAMPBELL JR, THENCE SOUTHERLY ALONG THE EAST LINE OF THE P[ARCEL CONVEYED TO FALCONER CAMPBELL JR, 204.2 FEET MORE OR LESS TO THE MOST SOUTHEAST CORNER THEREOF; THENCE WESTERLY PARALLEL WITH THE NORTHERLY LINE OF SAID SECTION 13, 760 FEET MORE OR LESS, TO A POINT ON SAID WESTERLY BOUNDARY LINE; THENCE SOUTHERLY ALONG SAID WESTERLY BOUNDARY LINE, 660 FEET, MORE OR LESS TO THE SOUTHWEST CORNER OF THE NORTHWEST QUARTER OF SAID SECTION 13; THENCE EASTERLY, ALONG THE BOUNDARY LINE 2460 FEET, MORE OR LESS, TO NORTH LINE OF SAID SECTION 13; THENCE WESTERLY 26.75 FEET TO THE POINT OF BEGINNING.

PARCEL 2

THAT PORTION OF THE WESTERLY RECTANGULAR 1752 FEET OF THE NORTHWEST QUARTER OF SECTION 13, TOWNSHIP 5 SOUTH, RANGE 6 WEST, SAN BERNARDINO BASE AND MERIDIAN, AS SHOWN BY UNITED STATES GOVERNMENT SURVEY, DESCRIBED AS FOLLOWS:

COMMENCING AT A POINT IN THE NORTHERLY LINE OF SAID NORTHWEST QUARTER DISTANT EASTERLY 1725.25 FEET FROM THE NORTHWEST CORNER THEREOF; THENCE SOUTHERLY PARALLEL WITH THE WESTERLY LINE OF SAID NORTHWEST QUARTER 1656 FEET; THENCE WESTERLY PARALLEL WITH THE NORTHERLY LINE OF SAID NORTHWEST QUARTER 430.5 FEET MORE OR LESS TO A POINT ON THE EASTERLY LINE OF THAT CERTAIN PARCEL OF LAND CONVEYED TO PAUL D BURNETT AND WIFE, BY DEED RECORDED JUNE 3, 1957, AS INSTRUMENT NO. 40469; THENCE CONTINUING WESTERLY, PARALLEL WITH THE NORTHERLY LINE OF SAID NORTHWEST QUARTER TO A POINT IN THE EASTERLY LINE OF THAT CERTAIN PARCEL OF LAND CONVEYED TO FALCONER E CAMPBELL JR, BY DEED RECORDED ON JUNE 18, 1957, AS INSTRUMENT NO 44152, WHICH LIES 760 FEET EAST OF THE WEST LINE OF SECTION 13, BEING THE TRUE POINT OF BEGINNING; THENCE SOUTHERLY ALONG THE EASTERLY LINE LINE OF THE AFOREMENTIONED CAMPBELL PARCEL TO THE SOUTHWESTERLY EXTENSION OF THE SOUTHERLY LINE OF THE AFOREMENTIONED BURNETT PARCEL; THENCE NORTH 87° EAST ALONG THE SOUTHWESTERLY EXTENSION TO THE SOUTHWEST CORNER OF SAID PARCEL CONVEYED TO BURNETT; THENCE NORTHERLY ALONG THE WEST LINE OF HE PARCEL SO CONVEYED TO BURNETT TO A POINT THEREON WHICH EARS 10 FEET MORE OR LESS EAST OF THE POINT OF BEGINNING; THENCE WEST 10 FEET MORE OR LESS TO THE POINT OF BEGINNING.

PARCEL 3

THAT PORTION OF THE NORTHWEST QUARTER OF SECTION 13, TOWNSHIP 5 SOUTH, RANGE 6 WEST, SAN BERNARDINO BASE AND MERIDIAN, AS SHOWN BY UNITED STATES GOVERNMENT SURVEY, DESCRIBED AS FOLLOWS:

COMMENCING AT A POINT ON THE NORTHERLY LINE OF THE SAID NORTHWEST QUARTER DISTANT EASTERLY 1725.23 FEET FROM THE NORTHWEST CORNER THEREOF; THENCE SOUTHERLY PARALLEL WITH THE WESTERLY LINE OF THE SAID NORTHWEST QUARTER, 1656 FEET; THENCE WESTERLY, PARALLEL WITH THE NORTHERLY LINE OF THE SAID NORTHWEST QUARTER, 430.5 FEET, MORE OR LESS, TO A POINT ON THE EASTERLY LINE OF THAT CERTAIN PARCEL OF LAND CONVEYED TO PAUL D BURNETT AND WIFE, BY DEED RECORDED JUNE 3, 1957, AS INSTRUMENT NO 40469, THE TRUE POINT OF BEGINING; THENCE CONTINUING WESTERLY PARALLEL WITH THE NORTHERLY LINE OF THE SAID NORTHWEST QUARTER TO A POINT IN THE WESTERLY LINE OF SAID PARCEL OF LAND CONVEYED TO PAUL D BURNETT AND WIFE WHICH LIES 770 FEET EAST OF THE WEST LINE OF SAID SECTION 13; THENCE SOUTHERLY ALONG THE EASTERLY LINE OF THE AFOREMENTIONED BURNETT PARCEL TO THE SOUTHWEST CORNER OF THAT PARCEL OF LAND CONVEYED TO PAUL D BURNETT; THENCE NORTH 87° EAST ALONG THE SOUTHERLY LINE OF SAID BURNETT PARCEL 539 FEET TO THE SOUTHEAST CORNER THEREOF; THENCE NORTHERLY ALONG THE EASTERLY LINE OF SAID BURNETT PARCEL 25.5 FEET TO THE POINT OF BEGINNING.

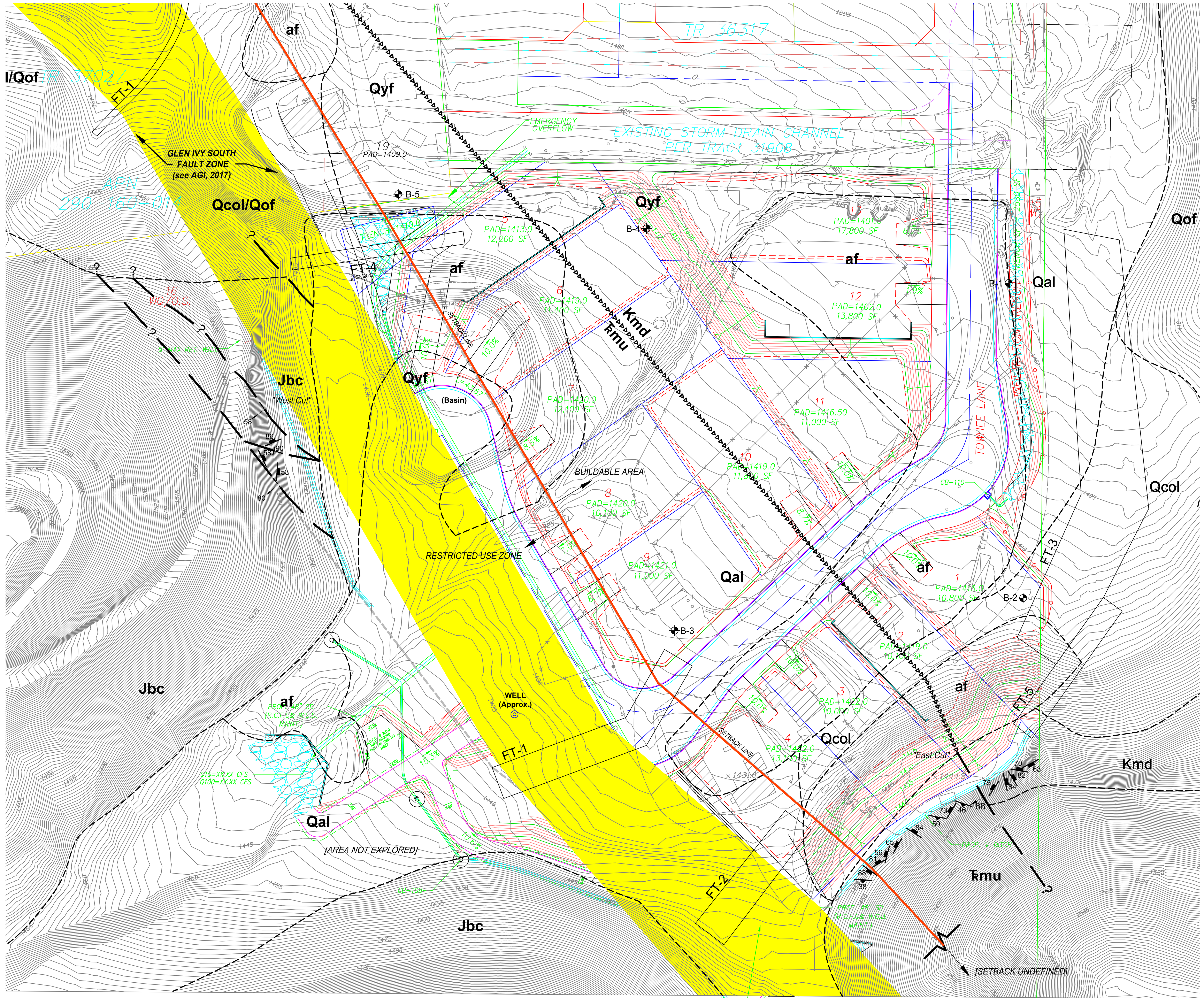
EXCEPTING THEREFROM AN EASEMENT FOR ROAD PURPOSES OVER THE EASTERLY 100 FEET OF THE ABOVE DESCRIBED PROPERTY,SAID 100 FEET BEING MEASURED ALONG THE NORTHERLY LINE THEREOF, AND THE WESTERLY LINE THEREOF BEING PARALLEL WITH THE WESTERLY LINE OF SAID NORTHWEST QUARTER.

PROJECT NOTES

1. THE EXISTENCE AND LOCATION OF ANY UNDERGROUND UTILITY PIPES OR STRUCTURES SHOWN ON THESE PLANS WERE OBTAINED BY A SEARCH OF THE AVAILABLE RECORDS. TO THE BEST OF OUR KNOWLEDGE, THERE ARE NO EXISTING UTILITIES EXCEPT AS SHOWN ON THIS PLAN. THE CONTRACTOR IS REQUIRED TO TAKE DUE PRECAUTIONARY MEASURES TO PROTECT THE UTILITY LINES SHOWN AND ANY OTHER LINES NOT OF RECORD OR NOT SHOWN ON THIS DRAWING.
2. CONSTRUCTION CONTRACTOR AGREES THAT IN ACCORDANCE WITH GENERALLY ACCEPTED CONSTRUCTION PRACTICES, HE/SHE WILL BE REQUIRED TO ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR JOB SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION OF THE PROJECT, INCLUDING SAFETY OF ALL PERSONS AND PROPERTY; THAT THIS REQUIREMENT SHALL BE MADE TO APPLY CONTINUOUSLY AND NOT BE LIMITED TO NORMAL WORKING HOURS, AND CONSTRUCTION CONTRACTOR FURTHER AGREES TO DEFEND, INDEMNIFY AND HOLD DESIGN PROFESSIONAL HARMLESS FROM ANY AND ALL LIABILITY, REAL OR ALLEGED, IN CONNECTION WITH THE PERFORMANCE OF WORK ON THIS PROJECT, EXCEPTING LIABILITY ARISING FROM THE SOLE NEGLIGENCE OF DESIGN PROFESSIONAL.
3. 2010 THOMAS BROS. MAP BOOK: PAGE 834, GRID G3
4. LAND IS NOT SUBJECT TO LIQUEFACTION OR OTHER GEOLOGICAL HAZARD AND IS NOT WITHIN A SPECIAL STUDIES ZONE.
5. LAND IS NOT SUBJECT TO OVERFLOW, INUNDATION OR FLOOD HAZARD.
6. PROJECT IS LOCATED IN A HIGH FIRE AREA.
7. ALL IMPROVEMENTS SHALL BE PER SCHEDULE "A" SUBDIVISION ORDINANCE 460.
8. NO SUBSURFACE SEPTIC SEWAGE DISPOSAL IS INTENDED.
9. THIS MAP DOES NOT INCLUDE THE ENTIRE CONTIGUOUS OWNERSHIP OF THE LAND DIVIDER.
10. THIS PROJECT IS LOCATED WITHIN THE TEMESCAL CSA #134 – STREET LIGHTING.
11. FLOOD ZONE X, AREA OF MINIMAL FLOODING PER FEMA PANEL 6065C2005G.
12. NO KNOWN EXISTING WELLS ON OR AROUND THE PROPERTY.

LOT	NET S.F.	PAD S.F.
1		10,800
2		10,100
3		10,000
4		13,100
5		12,200
6		11,400
7		12,100
8		10,100
9		11,000
10		11,800
11		11,000
12		13,800
13		17,800

AVG. LOT SIZE=11,940 S.F.
0.38 DU/ACRE



0 20 40 80 120 160
SCALE
SCALE: 1"=40'

GEOTECHNICAL LEGEND

- B-5 Approximate location of exploratory boring
- FT-3 Surveyed limits of exploratory fault trench
- Geologic contact, approximately located
- 79 Fault, approximately located, with dip and dip direction
- Interpreted basement rock contact, concealed
- 63 Strike and dip of joint
- 50 Strike and dip of foliation
- af — Man-made fill
- Qcol — Colluvium
  Dark brown silty sand, porous
- Qyf — Younger fan alluvium
  Predominantly silty sand and gravelly sand
- Qof — Older fan alluvium (Morton & Miller, 2006)
  Light yellow arkosic sediments, non-indurated but with cemented surficial horizons
- Jbc — Bedford Canyon Formation
  Graywacke and impure quartzite
- Kmd — Granitic intrusive rock
- Ŧmu — Triassic metasediments
  Foliated phyllite and quartzite

OWNER/APPLICANT

KYLIE FAMILY TRUST
2279 EAGLE GLEN PARKWAY
CORONA, CA 92883
PH: (951) 603-0966

ENGINEER

adkan ENGINEERS
6879 AIRPORT DRIVE
RIVERSIDE, CA. 92504
951-688-0241

UTILITY PURVEYORS

WATER: TEMESCAL VALLEY WATER DISTRICT
SEWER: TEMESCAL VALLEY WATER DISTRICT
GAS: SOUTHERN CALIFORNIA GAS COMPANY
ELECTRICITY: SOUTHERN CALIFORNIA EDISON COMPANY
TELEPHONE: AT&T, VERIZON
CATV: TIME WARNER CABLE

ASSESSORS PARCEL NUMBER

290-160-011

LEGEND

PROP DOMESTIC WATER
PROPOSED RECLAIMED WATER
PROPOSED SEWER
TRACT BOUNDARY
A.D.A ACCESS RAMP

SD = STORM DRAIN
TC = TOP OF CURB
FS = FINISH SURFACE
SWR = SEWER
TRW= TOP OF RETAINING WALL
CL = CENTER LINE
FG = FINISHED GROUND
WTR= WATER
E/P = EDGE OF PAVEMENT
P/L = PROPERTY LINE
R/W = RIGHT OF WAY
A.R = A.D.A ACCESS RAMP
SW = SIDEWALK
( ) = EXISTING ELEVATION
C&G = CURB AND GUTTER
S.F. = SQUARE FEET
FS = FINISH SURFACE
FH = FIRE HYDRANT
TW = TOP OF WALL
TF = TOP OF FOOTING
HOA = HOME OWNERS ASSOCIATION

EARTHWORK QUANTITIES

CUT: XXX CY FILL: XXX CY NET: 0 CY
THE QUANTITY SHOWN ABOVE IS FOR DISCUSSION PURPOSES ONLY.

TENTATIVE TRACT SUMMARY

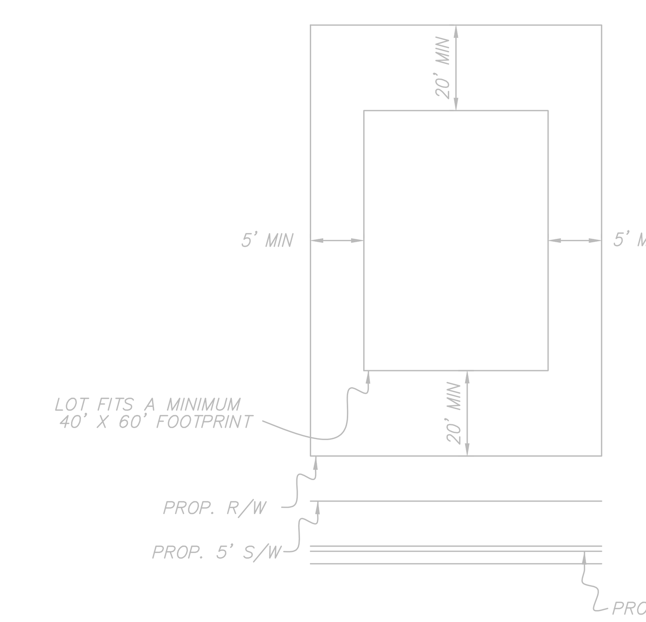
TOTAL AREA GROSS: 34.1 ACRES
EXISTING ZONING: R-R
PROPOSED ZONING: R-1
PROPOSED LAND USE: VLDR
EXISTING LAND USE: VLDR
EXISTING SURROUNDING LAND USE: RESIDENTIAL & OPEN SPACE
EXISTING SURROUNDING ZONING: SP (PER CZ 7317)

BENCHMARK

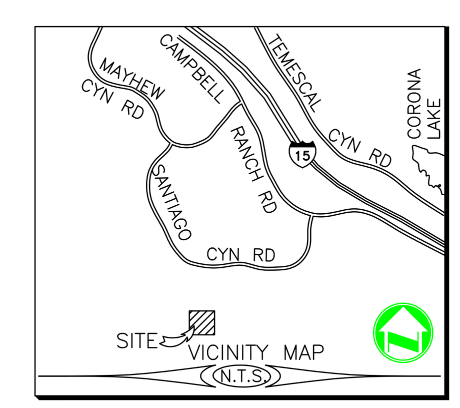
ELEV. 1170.39 NGVD 29
B.M. NO. CDH B.M. 58-B-77
BRASS DISK IN CONCRETE DOWN 0.5'
224' RT OF 575+48 1-15 CL IMP.

BASIS OF BEARINGS

THE WEST LINE OF THE SOUTHEAST ¼ OF SECTION 20, TOWNSHIP 2 SOUTH, RANGE 3 WEST WITH A BEARING OF N00°10'09"E WAS HELD AS THE BASIS OF BEARING FOR THIS MAP AS SHOWN ON PARCEL MAP BOOK 152, PAGES 60-61, LOCATED IN THE COUNTY OF RIVERSIDE RECORDERS OFFICE.



TYPICAL PAD/SETBACK DETAIL
N.T.S



VICINITY MAP
(N.T.S.)

SEC. 13, T.5S, R.6W

GEOTECHNICAL MAP		
TENTATIVE TRACT MAP NO. 37154, TEMESCAL VALLEY, CA		
PROJECT NO. 4252-SF	DATE: 1/30/17	PLATE NO. 1

REVISIONS	
DELTA	DESCRIPTION

TENTATIVE TRACT NO. 37154
PREPARATION DATE : JUNE 2016

adkan ENGINEERS
Civil Engineering • Surveying • Planning
6879 Airport Drive, Riverside, CA 92504
Tel:(951) 688-0241 • Fax:(951) 688-0599

Plot Date: 2/7/2017

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